North Coast Watershed Assessment Program

DRAFT

Redwood Creek Watershed Synthesis Report

The mission of the North Coast Watershed Assessment Program is to conserve and improve California's north coast anadromous salmonid populations by conducting, in cooperation with public and private landowners, systematic multi-scale assessments of watershed conditions to determine factors affecting salmonid production and recommend measures for watershed improvements.

Public Review Draft

Land Use History of Redwood Creek

Compiled for the North Coast Watershed Assessment Program

Public Review Draft
January 16, 2002

James Erler
California Department of Forestry and Fire Protection
North Coast Watershed Assessment Program

Overview

Redwood Creek covers 282 square miles (180,000 acres) of forested upland topography. The basin is 65 miles long with the headwaters located near Board Camp Mountain, in Northern Humboldt County. The watershed drains into the Pacific Ocean near the town of Orick. Elevation within the basin ranges from sea level at the town of Orick up to 5200 feet at Board Camp Mountain. Vegetation varies from Old Growth Redwood Forest along the lower portion of the drainage to Douglas-fir, intermixed with oak woodlands and hardwoods to Ponderosa and Jeffery Pine stands along the upper elevations. Areas of grasslands are also found along the main ridge tops and south facing slopes of the watershed. Prior to the harvesting of timber within the Redwood Creek watershed, 83 percent of the drainage supported mature coniferous forests. The remainder of the watershed, approximately 17 percent, supports grasslands and oak woodlands. Redwood Creek drainage currently supports 24,315 acres of old-growth coniferous forests. Approximately 68 percent of the total watershed area has been logged at least once.

For the purpose of the NCWAP study of Redwood Creek, the basin has been divided into five key areas (Table 1). Area one is the estuary, which takes in the flood plain around Orick up to the Prairie Creek confluence. Area two is the Prairie Creek drainage. The lower portion of Redwood Creek from Prairie Creek up to the upper Park Boundary is the lower basin. The middle basin is the area between the Park boundaries, near Coyote Creek, upstream to Lupton Creek, near the Highway 299 Bridge. The upper watershed area is the remainder of the drainage basin upstream of the Highway 299 Bridge. These five areas were delineated based on history, climate, rainfall, vegetation, and land use and ownership patterns. There are 23 planning watersheds as defined by the Cal water 2.2 system. One of these planning watersheds, Boat Creek, consists of a small series of coastal streams outside of the Redwood Creek Basin. Redwood National Park has identified 74 tributary basins, which contain a second order or higher stream.

Table 1. Subbasin Summary Table For Redwood Creek.

	Redwood Creek Sub Basin Summary					
Basin	**Estuary**	**Prairie Creek**	**Lower**	**Middle**	**Upper**	**TOTAL**
Area (ac.)	3,429	25,338	44,487	64,090	43,342	180,686
Roads (mi.)	58	271	327	461	382	1,499
Acres Harvested	563	3,521	28,654	49,830	16,807	99,058
Hardwoods	417	1,204	8,452	11,412	14,304	35,789
Grassland	0	312	752	4,016	3,889	8,969
Forested	1,302	23,774	34,716	48,186	22,638	130,616
Converted Acres	1,710	48	0	20	0	1,778

Land Ownership

Prior to 1968 most of the Redwood Creek drainage was held in private ownership. Timber companies or large family ranches owned most of this ownership ranches. During this time timber harvesting was the dominant land use. Creation of the Redwood National Park in 1968 and expansion ten years later led to a change of land use within the Redwood Creek area. Logging was no longer the principal land use in the lower part of the drainage.

Currently 43 percent of the entire watershed is within public ownership (Table 2 and Figure 1). Privately held timberlands account for 56 percent of the ownership (101,142 acres) within the Redwood Creek Basin. The Redwood Creek Landowners Association is comprised of ten private landowners (Landowners Association 2000) ranging from small to large industrial tracts, which own and manage lands within Redwood Creek. This collective ownership accounts for more that 80 percent of the privately owned property in the watershed. Eight large ownerships of larger than 3,000 acres each account for 90 percent of this total. Some of these members have managed land within the basin for fifty years or longer. These members represent a mix of land uses, including ranching and forest management activities and uses.

Table 2 outlines the percentage of ownership for the four main public agencies, which have land management responsibilities within Redwood Creek. These figures represent a consolidation of the ownership patterns, which existed during the beginning of the 20th century. The 1911 "Denny's Official County Map" showing property ownership of Humboldt County, including the Redwood Creek area reveals a much more fragmented land ownership pattern. Land sections are divided up into multiple ownerships with each section containing as many as six ownership names. Names such as; Hammond Lumber Company, B.L. Lyons, Hill – Davis Company, Collins, Russ and Sons, Solomon, Merryman Fruit Land and Lumber, Thomas & Bair, Gold Bluff Mining & Lumber, Warren Timber Company, Trinity National Forest, C H Wright and J D Tilley just to name a few. Northern Mountain Power Company could also be included in this partial list because of their power line that bisected Redwood Creek. This power line was located within the same location as the present day right of way.

Table 2. Acres and Percentage of Ownership within Redwood Creek

		BASIN	FED Only
National Park	66,696 ac	36.9%	92.7%
State Park	6,620 ac	3.7%	
BLM	3,599 ac	2.0%	5.0%
USFS (Six Rivers)	2,537 ac	1.4%	2.3%
Private	101,142 ac	56.0%	
Total	*180,594 ac*	*100.0%*	*100.0%*

As the demand for forest products increased by 1950 and timber operations became the principal land use within Redwood Creek, companies began to increase their land base. Smaller companies and individual holdings were bought up or the timber rights were acquired by the larger more viable operations. As a result of this ownership consolidation almost all of the privately held land became subject to forest management and timber harvests.

Early Land Use

Native Americans made extensive use of Redwood Creek, especially along the main channel of Redwood and Prairie Creeks (Foster, Pers Comm.). Extensive villages were located along the flood plain near the mouth of the ocean. The Yurok People have occupied approximately 300,000 acres (Lara 1996) covering the area from the mouth of Little River through the lower portion of Redwood Creek and north to Wilson Creek and inland to Bluff Creek along the Klamath River. Waterman recorded no fewer that five villages during his work on the Yurok Tribe in 1923. The rich forests of this region were teeming with wildlife and the streams were full of fish. Fire was also used as a land management tool. Forest were burned on a frequent basis to reduce the fuel loading as an aid to hunting. Although the Yurok People did not harvest redwood trees a fallen redwood tree or portions of the tree were well utilized. Uses of the redwood tree included; redwood sticks for cooking and drying various fish, for drying meat such as elk or sea lion, construction material for houses or sweat lodges, gill net floats, net needles, drum handles, baby baskets, storage baskets, ladies work dresses, chairs, pillows and the indispensable canoe.

Chilula people inhabited the lower and central portion of Redwood Creek. Chilula villages were located on or near lower Redwood Creek from the inland edge of the redwood belt to a few miles up stream of Minor Creek. Eighteen villages sites were recorded as belonging to these people. All but one (Kroeber 1976) of these sites was located on the eastern side of the creek. This was to take advantage of the of the increased sunlight and less timbered areas.

A third group of Native Americans that inhabited Redwood Creek were the Whilkut people. They occupied upper Redwood Creek area upstream of the Chilula to the headwaters and portions of the Mad River and Grouse Creek drainages.

Settlement of the Orick area was first recorded in the 1850's. During January 1851, a small gold rush broke out over the beach sand at Gold Bluff. Miners, seeking to develop the area north of Redwood Creek, in the area of the "bluffs" and Majors Creek, first settled in the area. The alluvial plain in and around Orick was cleared of the extensive Sitka Spruce stands, hardwood trees and thick brush and converted to farm and grazing land. This converted area accounts for less than one percent of the total basin area. The upper areas of Redwood Creek were becoming utilized and populated during this same time period. Miners and settlers were moving into the basin. The initial use of hardwoods in this area was for fuel wood, fence posts, and tanbark. Tanbark, bark from the tanoak tree was used for the tanning of hides.

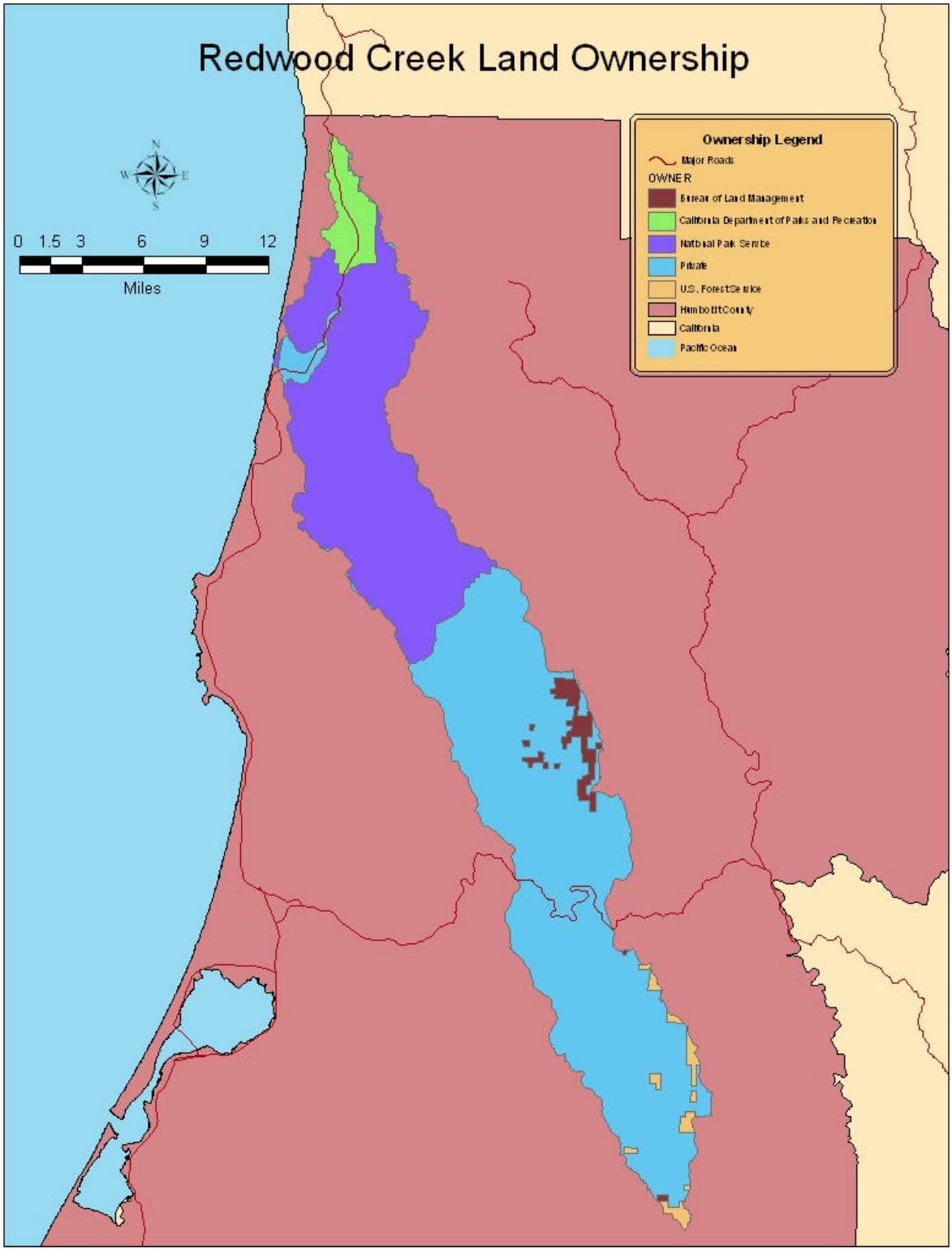

Figure 1. Redwood Creek Land Ownership Patterns.

Cattle ranching and sheep farming were beginning to utilize the native meadows, grasslands and oak woodlands. Cattle were being moved into the Redwood Creek area and by 1860 extensive herds were located along the Bald Hills and Upper Redwood Valley. After 1865 the sheep and wool industry became the leading agricultural enterprise in the eastern portion of the valley, away from the dense stands of timber. Excellent stands of native grasses provided year-round grazing and were well suited for sheep grazing. Wool produced in this area of Humboldt County was considered to be the best grown on the Pacific Coast and always brought the highest prices on the open market (Green 1980). Up until 1940 there was an estimated 15,000 to 20,000 sheep within the Bald Hills and Redwood Creek area (Stover, pers. com). With this large number of animals within a relatively small area one can only speculate as to the amount of impacts from this enterprise. The only land base, which could be used for grazing, was the natural grasslands and oak woodlands. These two areas amount to approximately 32,000 acres of suitable rangeland. These figures would indicate that there were approximately 1 to 2 sheep per acre. This figure is well above the recommendation of no more that one animal per four acres. This ratio can be even as high as one sheep for 20 acres on low quality rangeland (Stoddart, Smith and Box 1975). Once the carrying capacity of the range is exceeded and the area is overgrazed, adverse effects can be noted. Effects such as; reduced forage production, creation of bare and unstable topsoil, loss of top soil, increased erosion, creation of gullies, invasion of the site by lower quality plants, increase in the percentage of annual plants and reduction in the number of plant species present. Although the possibility of historic overgrazing the Redwood Creek land base, which could have lead to the incipient stages of erosion in the watershed, is beyond the scope of the NCWAP program, it may warrant further study.

Forest Management

Four key factors appear to have played a deciding role in how timber was harvested within Redwood Creek and the North Coast in general. These factors being; timber taxation, the newly enacted Forest Practices Act of 1945, timber demand, and the advent of the crawler tractor. Until the "Minimum Diameter Law" was repealed in 1955, (Arvola 1976) which prohibited the commercial cutting of coniferous trees of less than 18 inches in diameter, timber companies were required to leave standing timber for reforestation. Until the time of the new timber yield tax laws in 1977, standing timber was taxed on its assessed value on an annual basis. The Forest Practice Act of 1945 also required that no more that 70 percent of the timber could be removed during a harvest. This led to the perceived notion that redwood trees within the lower portion of Redwood Creek were being logged under a seed tree or selection method of silviculture. This was commonly referred to as a "tax cut" (Tangen, pers com). To allow for forest management options the Forest Practice Act provided a section that permitted a landowner to submit an alternative plan to the Rules. Selection harvesting was generally the normal silviculture prescription until a windstorm in 1959 caused a significant amount of blow down in a harvest unit owned by Arcata Redwood Company just north of Orick. This severe damage led to the change from selection harvest to clear cutting. This change would also require that an alternative plan be written and approved by the Board

of Forestry. Prior to the Board hearing the matter, Director DeWitt Nelson of the Department of Natural Resources visited the site to discuss the proposal with the company President Howard Libby (Arvola 1977). This alternative plan to clear cut 835 acres was approved by the Board of Forestry in April of 1960. A review of the alternative plan in February of 1961 did not indicate any problems, even though the plan was adjacent to or in close view the Redwood Highway (Highway 101). This plan was amended and enlarged two different times. Each time the cry of visual impacts from clear cutting could be heard. These cries soon became heard and eventually led to the creation and expansion of Redwood National Park.

Initial timber harvests are visible on the 1942 aerial photos. This early logging was conducted with steam donkeys and cable systems as evident from the tell tale yarding patterns in the photos. Some early tractor logging started in the late 1930's but does not become highly utilized until after the end of World War II. The post war years and associated housing boom created an increase in the demand for Douglas-fir logs. This led to an increase in logging within the middle and upper portions of Redwood Creek. During the period from 1949 to 1954 19 percent of the area was logged (Best 1984). This increase demand for Douglas-fir logs resulted in a significant amount of area that produced the vast tanoak stands, which are visible in the area today (Houston). Today, these almost pure tanoak stands are being harvested and utilized. Once the stands are cut the area is replanted to the native Douglas-fir to reintroduce the tree to the site.

Tractors had been tried as early as 1924 in the redwood region but could not compete with the steam donkeys. By the beginning of World War II, approximately 50 percent of redwood logging was by tractor in place of steam power. War requirements precluded their further increase in use. It was even speculated in *The Forest Situation in California, Report to the Legislature* (California Legislature 1945) "that even after the war and when tractors become available, they will not be used under some terrain and weather conditions. Winter weather in the redwoods brings deep slippery mud on which tractors are not effective, particularly on steep slopes. Under such conditions, clear cutting will be continued until a way is found to employ tractors in deep mud or a different type of yarding machine is developed." Once the War ended, tractors became the principal means of skidding the large logs to the landings after. Large skid trails were necessary due to the size of the equipment and logs. During this period logging arches were employed which increased the size of these trails. The tractor logging arch was developed on the Pacific Coast for skidding the large logs encountered there. It proved to be an effective tool for yarding logs in the redwood region. The arch was a large track mounted piece of equipment pulled by a crawler tractor. In tractor arch operations chockers were set to the log and the winch line of the tractor. The logs were then winched up into the arch and hoisted clear of the ground. Use of the arch allowed for the leading end of the log to be lifted off of the skid trail and clear of the ground. Use of the arch had advantages during yarding operations. These advantages included; less skidding resistance, higher skidding speed, cleaner logs and less cable wear (Conway 1976). Due to the size of the tractor arch combination there was a significant reduction in the maneuverability of the machine. This reduction resulted in an increase in the size of skid trails and landings. Each skid trail also needed a "turn around" for the tractor before it could connect to a turn of logs.

These large significant skid trails resulted in large cut banks, significant fills at low points and the increase in soil displacement. Development of the integral arch eliminated the tractor arch operations. The arch was now a part of the tractor and eliminated the need for a second piece of equipment.

Aerial photos from that time period indicate that the yarding pattern was down the slope and drainage. Overall ground disturbance was also increased due to the tractors ability to construct large layouts in a relativity short amount of time. Layouts consisted of building a flat lay for the tree to fall into to cushion the blow and prevent it from breaking up upon impact. Not only was the layout made flat by moving the soil but mounds of soft soil were also pushed up along the lay to absorb energy of the falling tree. A tractor-constructed layout was often 300 feet long and 20 feet wide. Prior to the advent of tractor constructed layouts they were made by hand. Early layouts amounted to nothing more than piling brush in the depressions and swales to make a flat cushioned bed.

Modern cable yarding methods did not become well utilized within Redwood Creek until around 1972 when Arcata Redwood Company brought in the first highlead system (Hooven pers com). Introduction of cable yarding systems along with the newly legislated Forest Practices Act of 1972 modified somewhat how timber was yarded within the drainage. There was an increase in the use of ridge top landings and mid-slope road construction. Clear-cutting units were reduced in size from the massive cuts of the 1950,s to areas of 80 acres each. Buffers between clear-cut blocks were also utilized during this time period as part of the new Rules. Changes on the ground can also be seen on the aerial photos that are the result of regulatory change. The popular use of "cable below the road and tractor above" is quite evident during this time and up until the early 1990's. With the addition of stream protection zones in 1984 to the regulatory toolbox, these protection measures become quite visible on the photos after 1984.

Vegetation Composition

Information on past and historical vegetation conditions is not available to compare changes in the types and condition of vegetation classes. Information on current vegetation was derived from 1994 multi-spectral scan information provided by the USFS remote sensing lab. The vegetation map layer is the source for CALVEG types. The minimum mapping size is 2.5 acres for contrasting vegetation types. Early 2002, an update of this vegetation data based on 1998 imagery will be available.

Currently there are five vegetation types that account for 87 percent (Table 3) of the vegetation in Redwood Creek. The largest type is Douglas-fir, which covers 58,964 acres. Type classifications of both redwood and redwood Douglas-fir cover a combined area of 56,192 acres. Of these three commercial timber types approximately 21 percent (24,315cres) is preserved as old-growth forests. The remainder of the vegetation) within the Redwood Creek drainage is comprised if 32 different and distinct vegetation types. All of these types have a combined total of 8,000 acres, approximately 13 percent of the watershed area. Table 3 shows all of the vegetation cover types found within Redwood Creek.

Table 3. Vegetation Types and Acres for the Redwood Creek Drainage.

Vegetation Type	Acres	Percent of Total
Northern Mixed Chaparral	4	Less than 1
Red Fir	11	Less than 1
Ultramific Mixed Schrub	13	Less than 1
Tule - Cattail - Sedge	18	Less than 1
Dune	19	Less than 1
Mixed Conifer - fir	21	Less than 1
Urban - Developed	49	Less than 1
Scrub Oak	160	Less than 1
Jeffery Pine	183	Less than 1
Ultramific Mixed Conifer	205	Less than 1
Coyote Brush	228	Less than 1
Mixed Conifer - Pine	260	Less than 1
Willow	346	Less than 1
Bigleaf Maple	362	Less than 1
North Coastal Mixed Shrub	376	Less than 1
Tree Chinquapin	393	Less than 1
Barren - Rock	413	Less than 1
Agriculture	420	Less than 1
Water	440	Less than 1
Huckleberry Oak	457	Less than 1
Blueblossom Ceanothus	503	Less than 1
Douglas-fir Pine	617	Less than 1
Calikornia Black Oak	667	Less than 1
Canyon Live Oak	839	0.45
Douglas-fir White Fir	1,317	0.71
White Fir	1,399	0.75
Sitka Spruce	2,213	1.18
Montane Mixed chaparral	2,733	1.46
Sitka Spruce - Redwood	6,153	3.28
Oregon White Oak	7,640	4.07
Red Alder	7,898	4.21
California Bay	8,957	4.78
Annual Grass - Forbes	10,413	5.55
Tanoak - Madrone	16,618	8.86
Redwood - Douglas-fir	23,139	12.34
Redwood	33,053	17.63
Douglas-Fir	58,964	31.45
Total Acres	187,501	

Several of these types as shown in Table 3 could indicate a change from the original pre-settlement vegetation. Urban-Developed areas account for 49 acres, mostly the town of Orick. Areas of coyote brush, (*Baccharis spp*.), blueblossom ceanothus (*Ceanothus thyrsiflorus*), and agriculture are vegetation types which may not represent the native vegetation in the total area originally found in the area. Agriculture (420 acres) is a definite change. This change is located mostly in and round the community of Orick. Blue blossom, an invader species mostly after fires or other ground disturbance, occupies 503 acres. Blueblossom Ceanothus along with coyote brush is found on the dryer south facing sites. Most of the coyote brush is concentrated in the area along the ridge of Copper Creek along with a minor amount in Coyote Creek. Blueblossom Ceanothus is found in scattered units in the basins of Panther Creek, Devils Creek, Roaring Gulch, Coyote Creek, Toss Up Creek and Lake Prairie. All of these pockets, with one exception, of blueblossom ceanothus are found in the area above the Park Boundary. The one exception is the small area in the Lake Prairie sub-basin where several units of the species are located.

Hardwood trees species associated with disturbance and land use change are also found within Redwood Creek. Currently red alder (*Alnus rubra*) covers 7,898 acres. Most of this area is located below the Bridge Creek subbasin and generally on the west side of Redwood Creek. The heaviest concentrations of the tree are found in the areas of intense logging activity in the 1970s. Although this species represents approximately 4 percent of the land base within the Redwood Creek basin distribution is limited to the area below Devil's Creek. No significant mappable concentrations are located above this area. Although this species can be found up to 100 miles inland and at elevations below 2500 feet it does not appear to occur above 600 feet in elevation along the main stem of Redwood Creek. Along the upper slopes red alder is not found above 1800 feet along the southern aspects. Another hardwood species, which is associated with land use activity, is tanoak (*Lithocarpus densiflours*). Tanoak can exist under a forest canopy with low light levels throughout most of its life. Once released the suppressed trees exhibit remarkable growth and development. The extensive tanoak stands (16,681 acres) may have developed from the post World War II harvest of the extensive Douglas-fir stands in the Upper Redwood Creek area.

Only the area of barren rock (413 acres), water (440 acres) and dunes (19 acres) are not currently supporting some type of vegetation. The barren-rock areas are scattered around the watershed, except for two large areas. The first larger area is the extensive gravel bars (129 acres) along Redwood Creek along the town of Orick and upstream above the Prairie Creek confluence. The second distinct area (72 acres) follows the new section of Highway 101, commonly referred to as the "bypass".

Estuary Sub basin

The estuary sub basin (Figure 2) has the largest amount of agriculture land (420 acres) within the Redwood Creek basin. Most of this cover type is in permanent grazing land and pasture. Developed acres within this sub basin account for the largest amount of development within Redwood Creek. Approximately 50 acres have been developed in

and around the community of Orick. Old growth redwood is also found within the sub basin, along with stands of cut over land that supports second growth conifers.

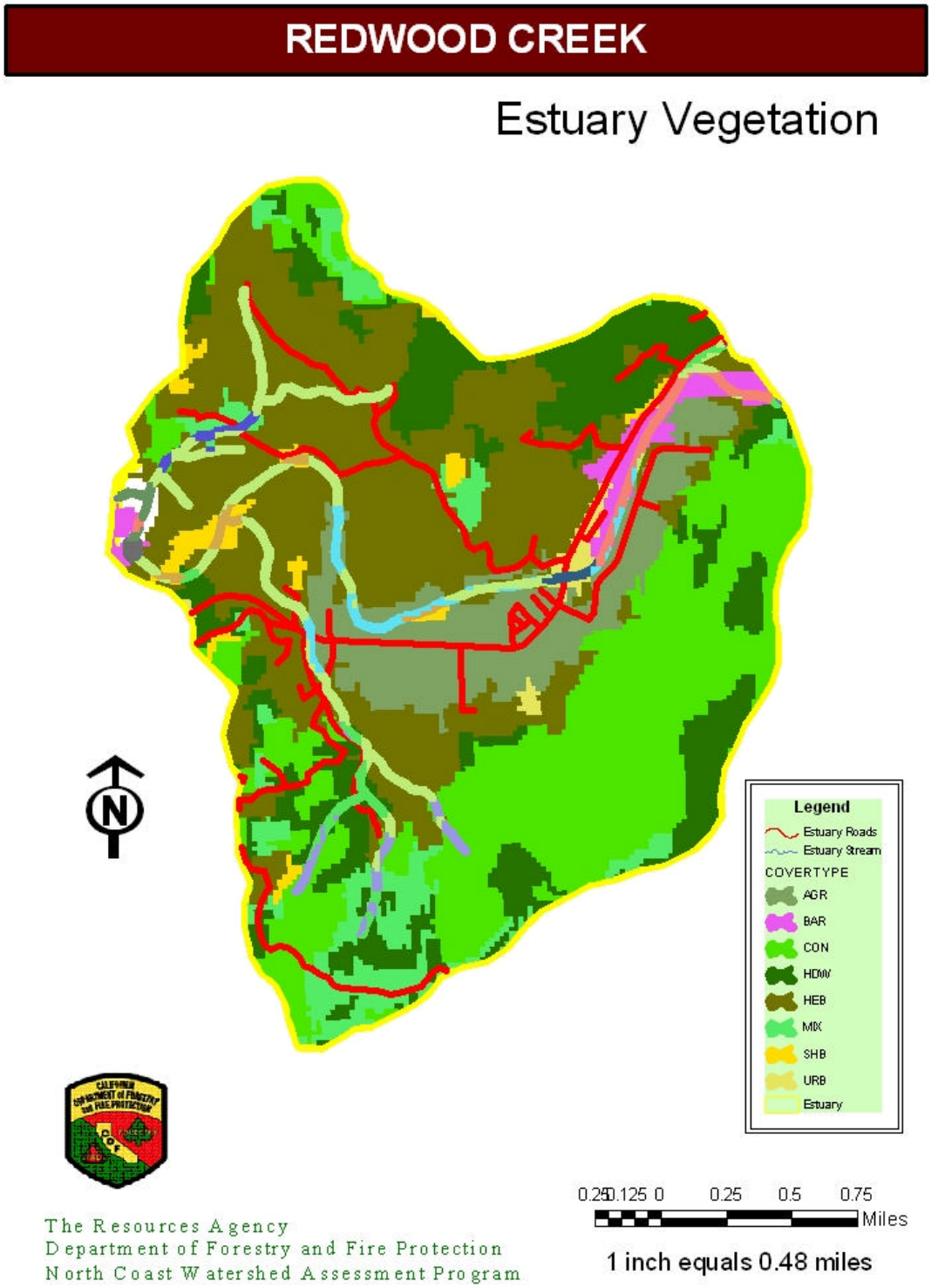

Figure 2. Estuary Subbasin Vegetation.

Prairie Creek

Vegetation within this sub basin (Figure 3) consists almost entirely of conifers. These conifer stands are, for the most part, two different types. Areas of old growth Redwood and Douglas-fir occupy most of the northern portion of the sub basin. Second growth redwood forests have become established on the previously harvested lands in the sub basin. These cut over stands now support healthy well stocked stands. Some of these second growth stands appear to be overstocked and are loosing vigor. Approximately 40 acres is prairie grassland. One area (72 acres) classified as barren follows the new section of Highway 101, commonly referred to as the "bypass". The areas (48 acres) which have been converted to another land use are several parcels located along the lower section of Prairie Creek. The largest area is where a currently operating sawmill is located. The land base in this sub basin appears to be productive and does not exhibit any significant vegetation impacts.

Lower Basin

A full spectrum of vegetation is found within the lower Redwood Creek sub basin (Figure 4). This sub basin contains 34,716 acres of forested landscape. Redwood, both old-growth and second growth, occupy most of this type. Douglas-fir also is a significant component of the forest. Approximately 750 acres is classified as grassland and 8,452 acres are stocked with hardwoods, mainly tanoak. Areas of Oregon white oak are found along the upper ridges of the sub basin in association with the grasslands. The land base in this sub basin appears to be productive and does not exhibit any significant vegetation impacts.

Middle Basin

Middle basin vegetation (Figure 5) consists of 48,186 acres of forestland along with 11,412 acres of hardwood forests. Although pure conifer stands are found within the sub basin, most of the forested landscape is comprised of mixed conifer hardwood stands. Grassland covers 4,016 acres within the sub basin. In addition small areas, scattered throughout the sub basin are covered with brush. Blueblossom ceanothus along with coyote brush is found in the dryer south facing sites. Past harvest units within the sub basin appear to be restocked and very productive. The Department of Forestry and Fire Protection's forest practice program did not indicate any harvest units within the sub basin which do not meet the stocking standards of the Forest Practice Rules.

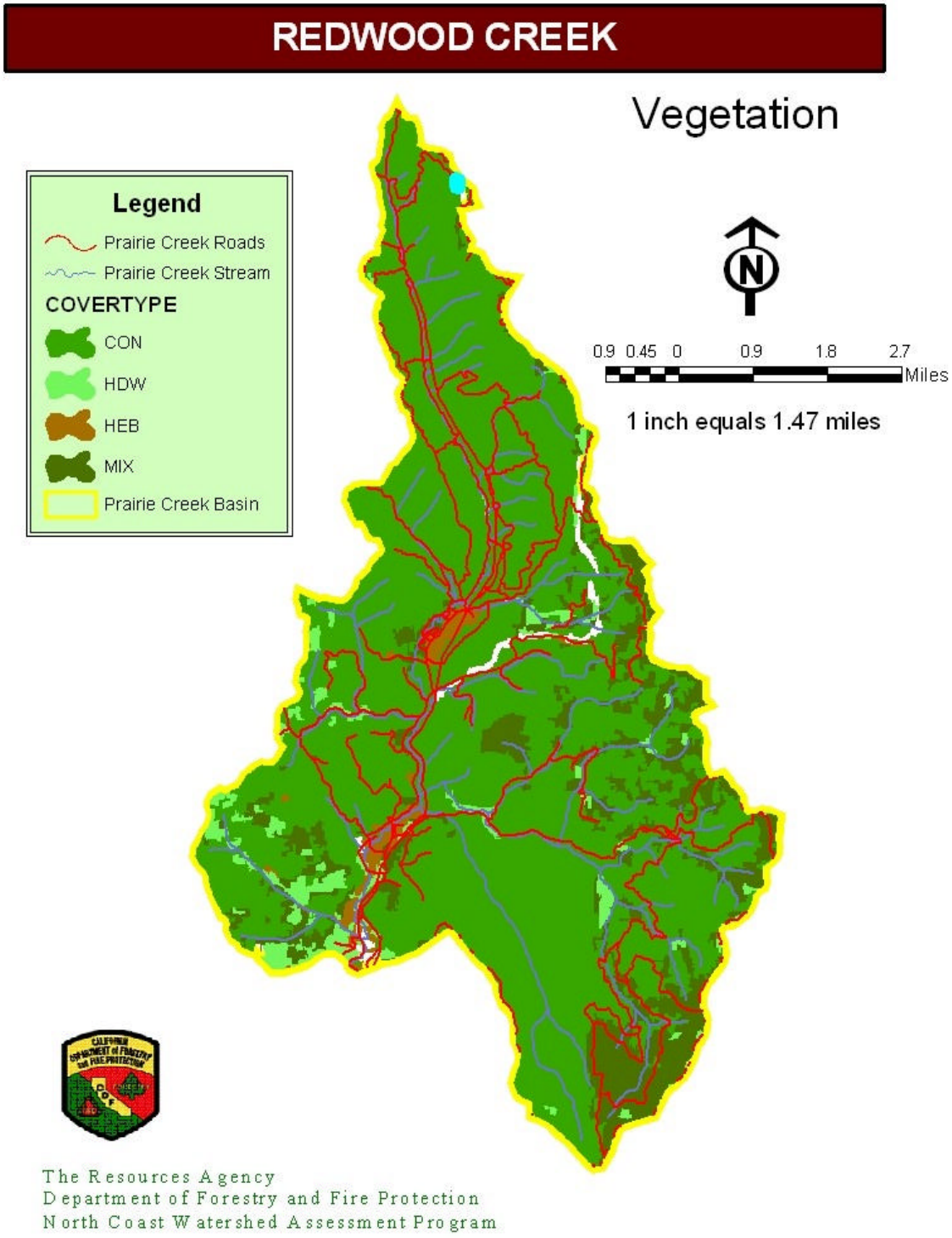

Figure 3. Prairie Creek Subbasin Vegetation.

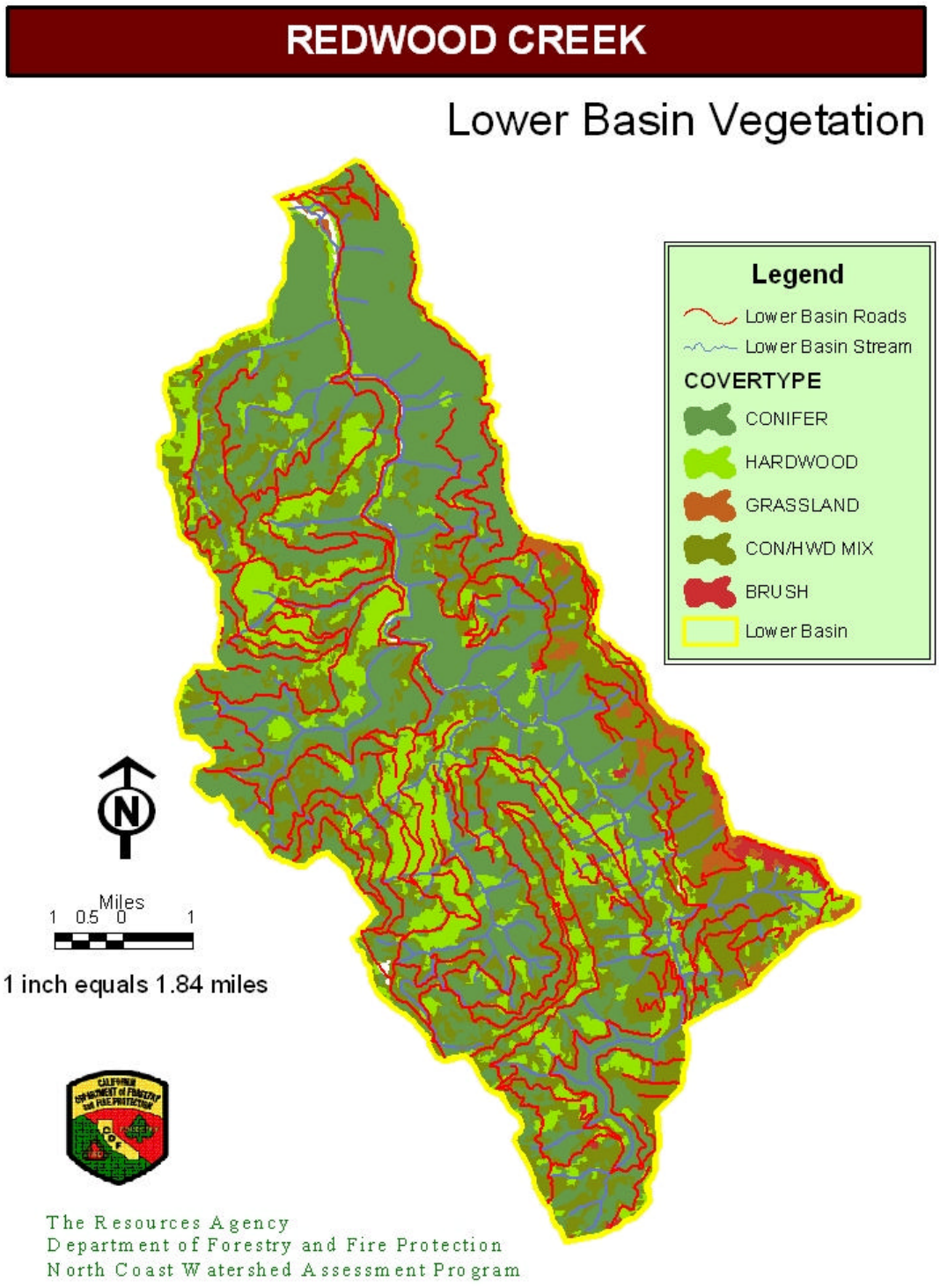

Figure 4. Lower Redwood Creek Subbasin Vegetation.

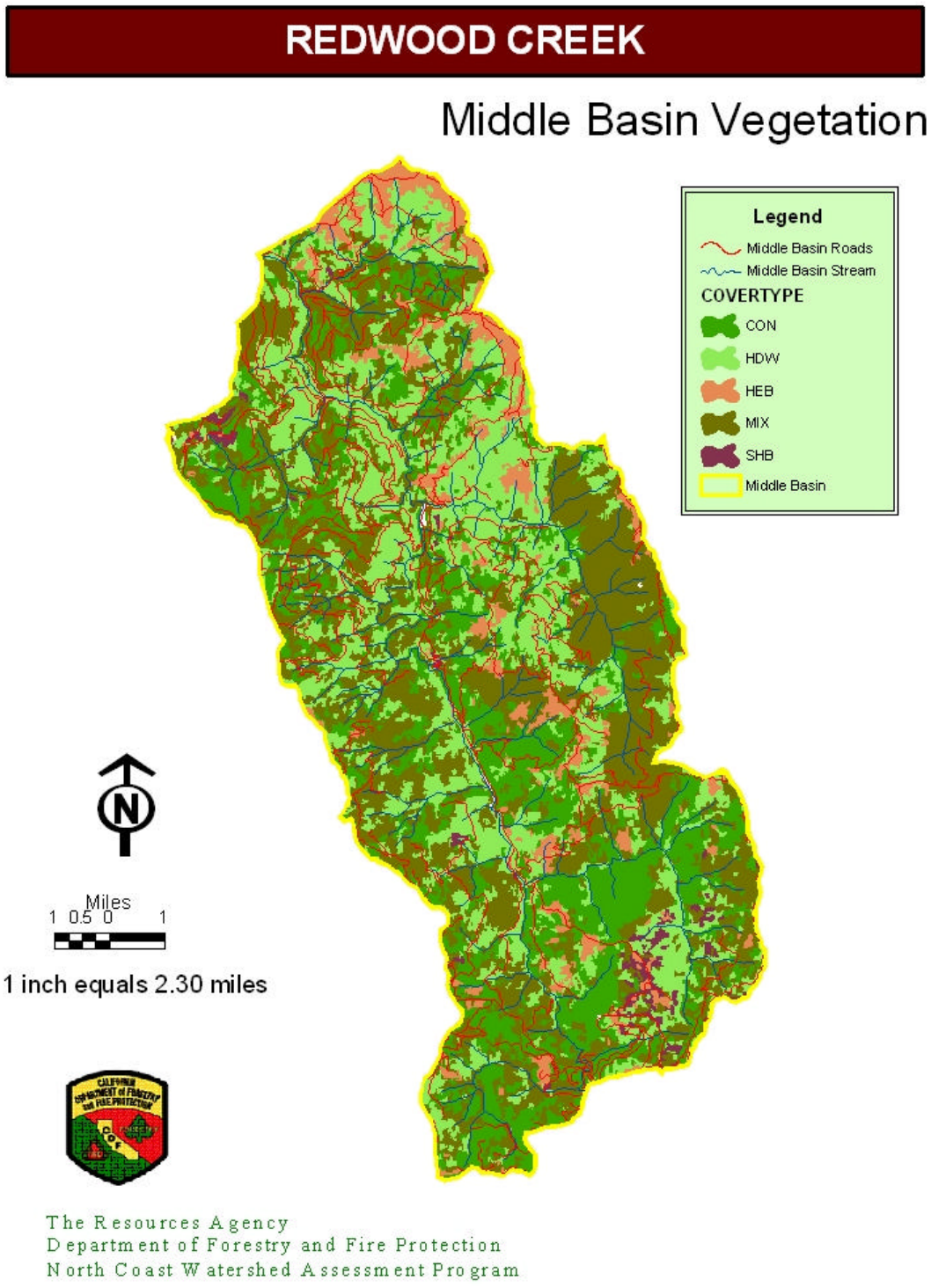

Figure 5. Middle Redwood Creek subbasin Vegetation.

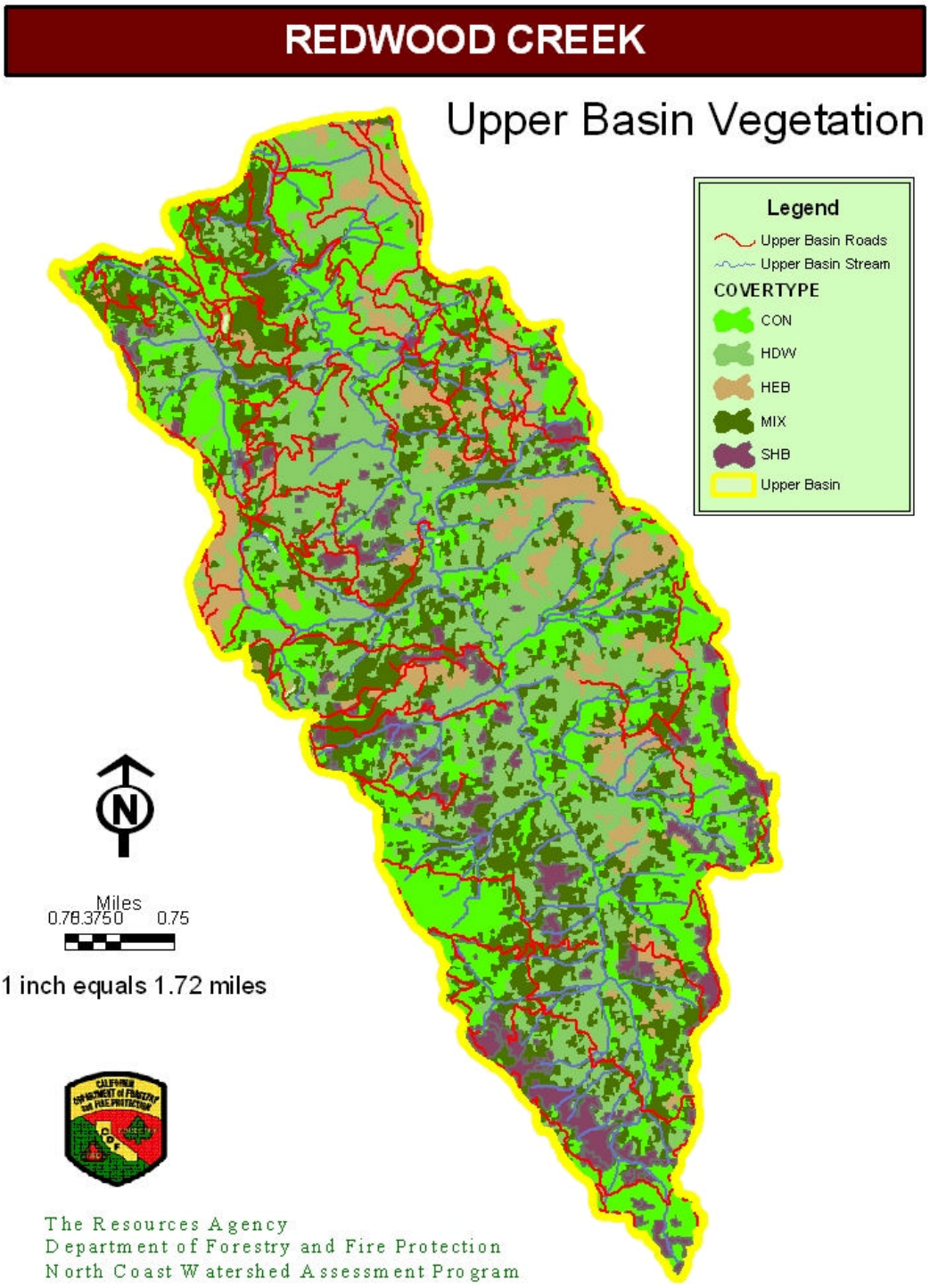

Figure 6. Upper Redwood Creek Subbasin Vegetation.

Stream Buffer Vegetation

Stream buffers are important to the protection of fish habitat for several reasons. With respect to stream temperature, dense trees immediately along a stream provide shade from direct sunshine on the stream surface. Stream buffers with dense canopy also help to reduce air temperature, thus reducing convective heat inputs to streams; however, scientific investigations are still uncertain as to how wide and dense buffers need to be to adequately provide for this microclimate effect.

Stream buffer analysis (Figure 7) was conducted to assess the amount of vegetation cover found along the watercourses within Redwood Creek. The data used for this analysis were the vegetation data, discussed above, plus a 1:24,000 stream coverage developed by CDF from the USGS digital line graphs. The predominant vegetation types found along the watercourses are shown in Figure 7 classed with tree canopy closure. The total buffer of 100 feet on each side of the watercourses covers approximately 5,340 acres.

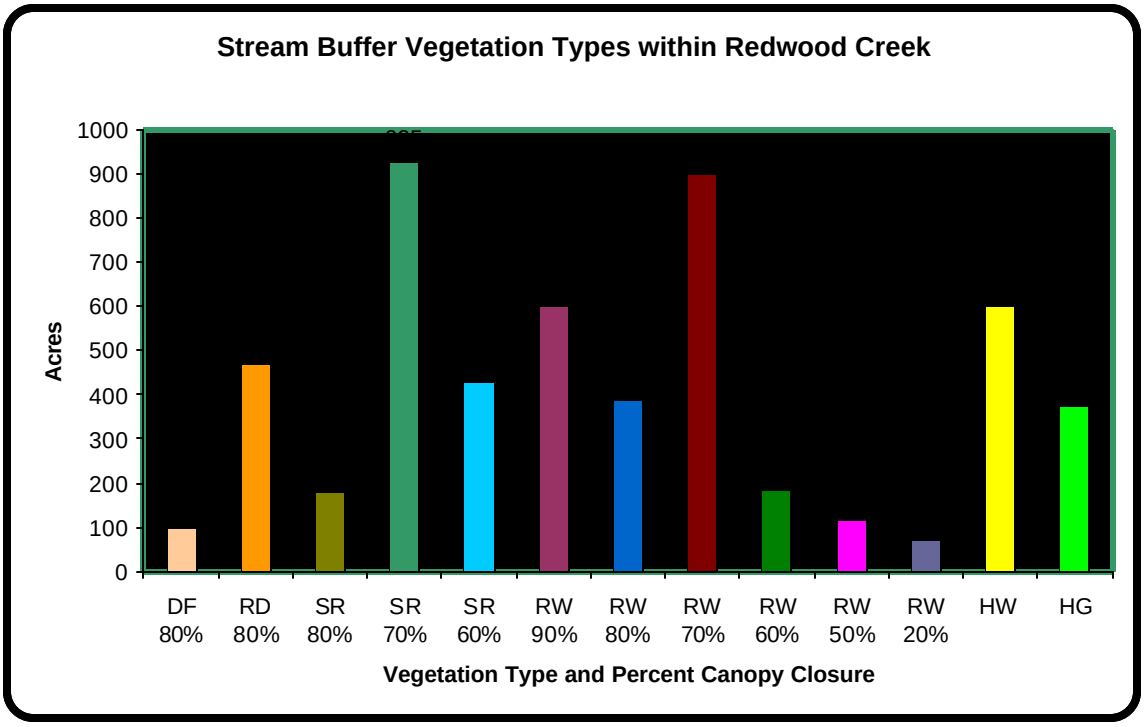

Figure 7: Stream Buffer Vegetation Type and Density Cover.

Vegetation type classes are shown as vegetation type and canopy closure is shown as percent. Douglas-fir (DF), Redwood – Douglas-fir (RD), Sitka Spruce – Redwood (SR), Redwood (RW), All hardwood species (HW) and annual grassland (HG) have no cover percent.

Annual grassland covers 376 acres and is found mainly along the upper reaches if small drainages and watercourses with a southern exposure and would not provide any shading of streams. Conifer classes within the higher crown cover percentage classes provide the

largest amount of cover along the streams. Conifers with canopy closure of 70 percent or greater occupy approximately 48 percent of the buffer area. Hardwoods cover 600 acres of the zone. Because of the eight separate hardwood species included in the vegetation information, canopy density was not calculated. Conifers occupy the lower portions of the basin, generally below Lacks Creek they start to become a more predominant component of the stream riparian area vegetation.

Stream Reach Assessment

Additional vegetation assessment was completed for the stream reaches surveyed by the Department of fish and Game. Digital vegetation information was utilized to determine the area and vegetation type, size class and canopy density for the 66 separate stream reaches. A buffer zone of 150 feet along each side of the stream reach was developed to determine specific vegetation information. The 150-foot buffer zone was used because it corresponds to the required watercourse and lake protection zones (WLPZ) outlined in the current Forest Practice Rules. The vegetation information was obtained from the CALVEG types. The minimum mapping size is 2.5 acres for contrasting vegetation types. The vegetation layers were then "clipped" to the GIS shape files for the stream reach assessment. Acres of cover type, tree density and percent canopy closure were then calculated utilizing Arc View GIS (Tables 4 and 5).

Table 4. Density and Cover Type Acres for the Stream Reach Buffer Assessment.

Density refers to the percent of crown closure for all trees within a given area. Cover types are derived from the standard CALVEG Classification system. Barren areas have less than 10 percent cover of any vegetation.

Density Percent	Acres
0 - 9%	13.1
10 - 19%	59.2
20 - 29 %	2.5
30 - 39%	4.5
40 - 49%	4.2
50 - 59%	27.5
60 - 69%	23.9
70 - 79%	8.5
80 - 89%	28.5
90 - 100%	5.3

Acres	Cover Type
0.4	Ag.
1.1	Barren
52.1	Conifer
61.9	Hardwood
1.7	Grass
58.0	Mixed
0.9	Shrub
1.2	Water

Table 5. Size Class Comparison Figures for the Stream Reach Assessment.

Size class refers to the diameter (DBH) size range for all of the conifers. Size class for hardwoods refers to average visible crown diameter. Refer to the chart above for a comparison.

Size Class Comparison Chart		
Size class code	**Conifer (DBH)**	**Hardwood (crown dia)**
1 Seedlings	1 - 4.9"	Less than 15'
2 Poles	5 - 11.9"	15 - 30 '
3 Small Trees	12 - 19.9"	30 - 45 '
4 Medium Trees	20 - 29.9"	Greater than 45'
5 Large Trees	30 - 40"	

Size Class	Acres
1	15.8
2	24.7
3	99.6
4	28.6
5	3.1

Timber Harvesting

Assessment of timber harvesting history was completed with the use of aerial photographs. Various photo flights from different available years were employed. Starting with the year 1942, which was the earliest flight readily available, photo flights for 1942, 1948, 1952, 1954, 1958, 1964 and 1977 were utilized to determine past harvest areas. For the decades of the 1980s and 1990s actual timber harvest plans were utilized along with satellite multi-spectral scanned image data (MSS). This MSS data was used to indicate changes in the vegetation and not just timber harvesting. Table 6 reflects the cumulative amount of timber harvesting within Redwood Creek (excluding Prairie Creek) as a percent of the total area. Logging within the Prairie Creek sub basin appeared to have stopped about 1968. By the end of 1948, approximately five percent of the basin area had been logged. The period from 1949 to 1954 19 percent of the area was logged (Best 1984). During this period logging was very severe but still differed throughout the drainage. Over half of the forestry operations took place in the middle portion of the watershed. Half of the acreage cut was from the upper third of the basin. During this period harvesting was very active in the Prairie Creek and May Creek areas with extensive clear-cuts visible on the 1954 photos.

From about 1954 to 1978 the rate of harvest within the Redwood Creek area remained fairly constant. Although there were annual fluctuations in the harvest from area to area the annual harvest was approximately 3000 acres per year. After 1966 the upper and middle areas had a drop in the areas harvest but the lower area of Redwood Creek harvest rate more that doubled. Prior to 1964 access roads were constructed along the bottom of

Table 6. Cumulative Harvest Percentage of Late Seral Forests within Redwood Creek, Excluding the Prairie Creek Area, for Key Years.

Cumulative Harvest (Basin excluding Prairie Ck)	
Year	**Pct**
1948	5
1954	21
1962	35
1978	62
2000	64

Redwood Creek and along some of the tributaries. These new access roads allowed for new logging areas to be opened up prior to the 1964 storm event. Most of the areas cut prior to 1970, as visible on the air photos are in larger clear-cuts few in number. By the end of 1978, 62 percent of the Redwood Creek land base had been logged. At this time logging had stopped in the lower third of the basin. Along the upper two thirds of the watershed relogging of previously entered areas was being conducted.

Estuary

Harvest operations within the estuary sub basin occurred prior to 1942 (Figure 8). Most of the area had been converted to other land used such as pasture land, and development as part of the settlement of the Orick area. A total of 1,710 were converted to some other non- forested land use. This accounts for most of the converted land within the entire Redwood Creek Basin. Since 1945 a total of 563 acres were harvested in the area. These harvested areas have become restablished with conifers and some hardwood stands.

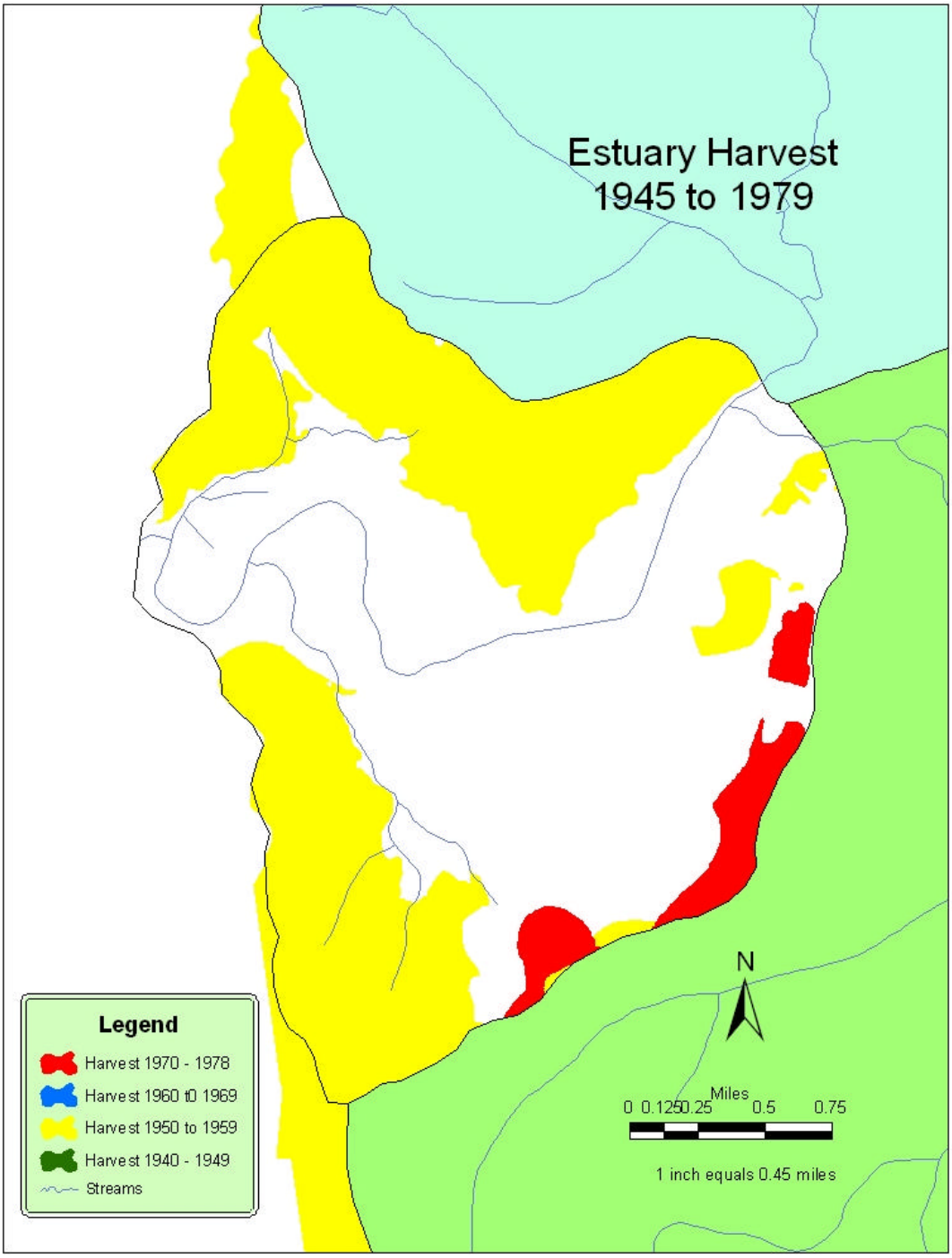

Figure 8. Timber Harvest within the Estuary Subbasin.

Prairie Creek

Some early tractor logging started in the late 1930's but does not become highly utilized until after the end of World War II (Figure 9). By 1948 the use of tractors had become the primary mover during yarding operations. It was during this time period that a majority of the roads in the May Creek, Prairie Creek, Skunk Cabbage and Lost Man Creek watershed appear to have been constructed. Routes of these haul road systems, for the most part, followed the drainages themselves. Landings, some quite extensive, were also built in or along the watercourse channel. A total of 3,21 acres were harvested within the Prairie Creek subbasin from the early 1940's until 1978. Most the major harvest operations occurred during the period from 1954 to 1963 in the area of May Creek. These harvested areas now support stands of well-stocked thrifty young growth forests.

Lower Basin Harvest

The highest percentage of the area logged was during the period of 1962 to 1978 (Figure 10). During this 16 year period 27 percent of the drainage was harvested. This amounts to approximately 49,000 acres, an average of over 3,000 acres per year. Most of this harvesting was centered within the areas of the watershed that would eventually become Redwood National Park. The second most active harvesting period was from the period of 1954 to 1962. During this time span of eight years 14 percent of the watershed was harvested. It should also be noted that from 1954 to 1978 timber harvesting within the Redwood Creek Drainage was at nearly even annual levels. The rate of harvest was fairly even at approximately 3000 acres per year being cut. A majority of this acreage was tractor yarded. Ground disturbance resulting from these prolonged operations is extensive, with some areas exhibiting well over 75 percent of the ground surface being disturbed. The use of tractor constructed skid trails, especially on the steeper slopes, is very evident. In some cases there appears to be a trail leading to every stump or log in the area.

Logging prior to 1942 was accomplished with the use of steam donkey skidding systems. Some harvesting was done in the headwaters of Devils Creek and Panther Creek. Some acreage in the vicinity of the mouth of Minor Creek and near the headwaters of Durdee Creek was also harvested with tractors. The area above Orick along the Bald Hills Road had been logged. Additional logging also took place in the area of Tom McDonald Creek, Devils Creek and High Prairie Creek. Several general observations were also noted from the various air photo years in regards to harvest methods. During the decade of the 50's and early 60's clear cuts were very large and extensive. Clear-cut units originating in the mid 1970's and later were much small with buffer zones between the cut blocks. With the introduction of cable systems in 1972 the road networks were beginning to be visible along the ridges and mid slope locations. Although the old roads still were located along channel bottoms, there was a lack on new road construction in these areas.

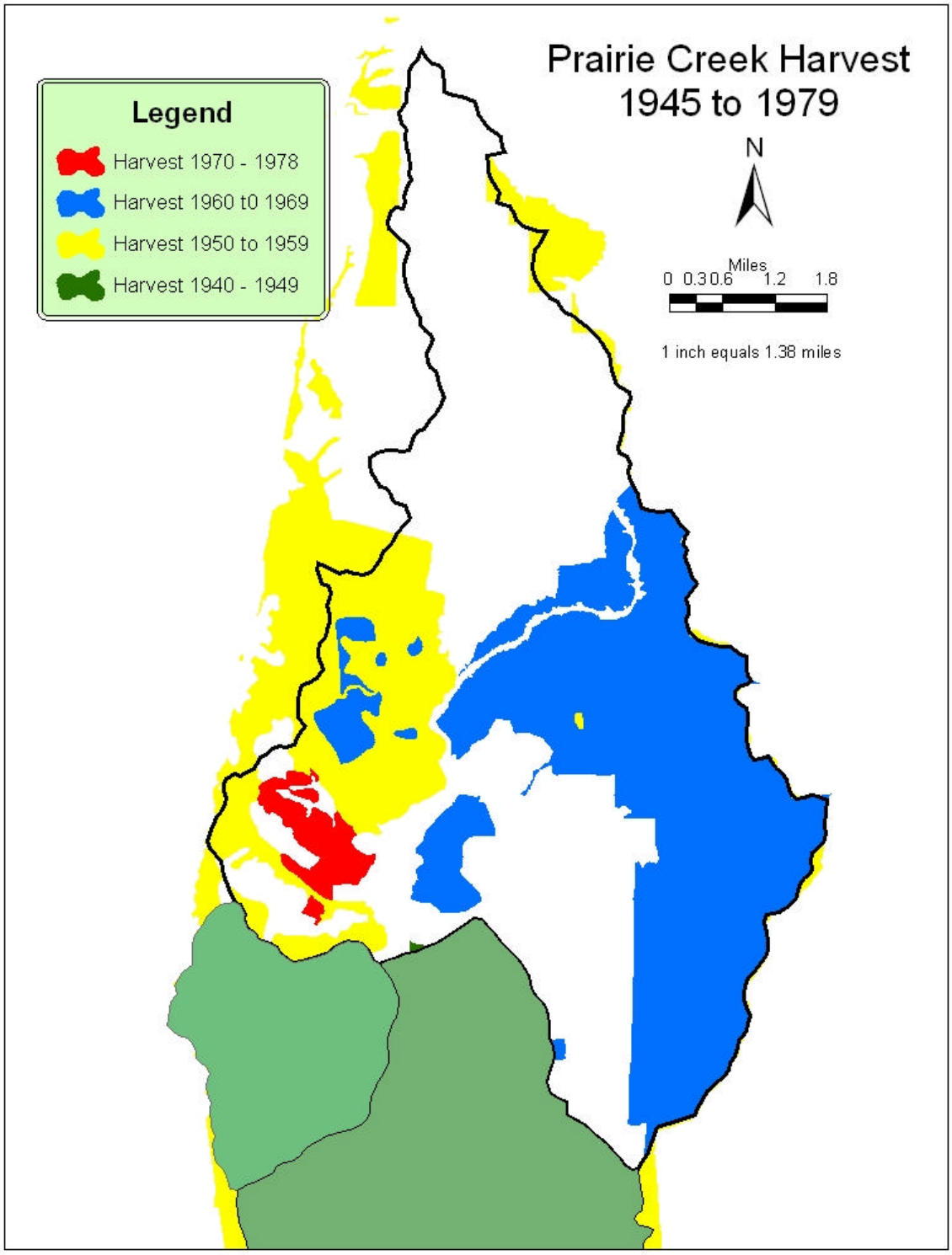

Figure 9: Timber Harvest within the Prairie Creek Subbasin.

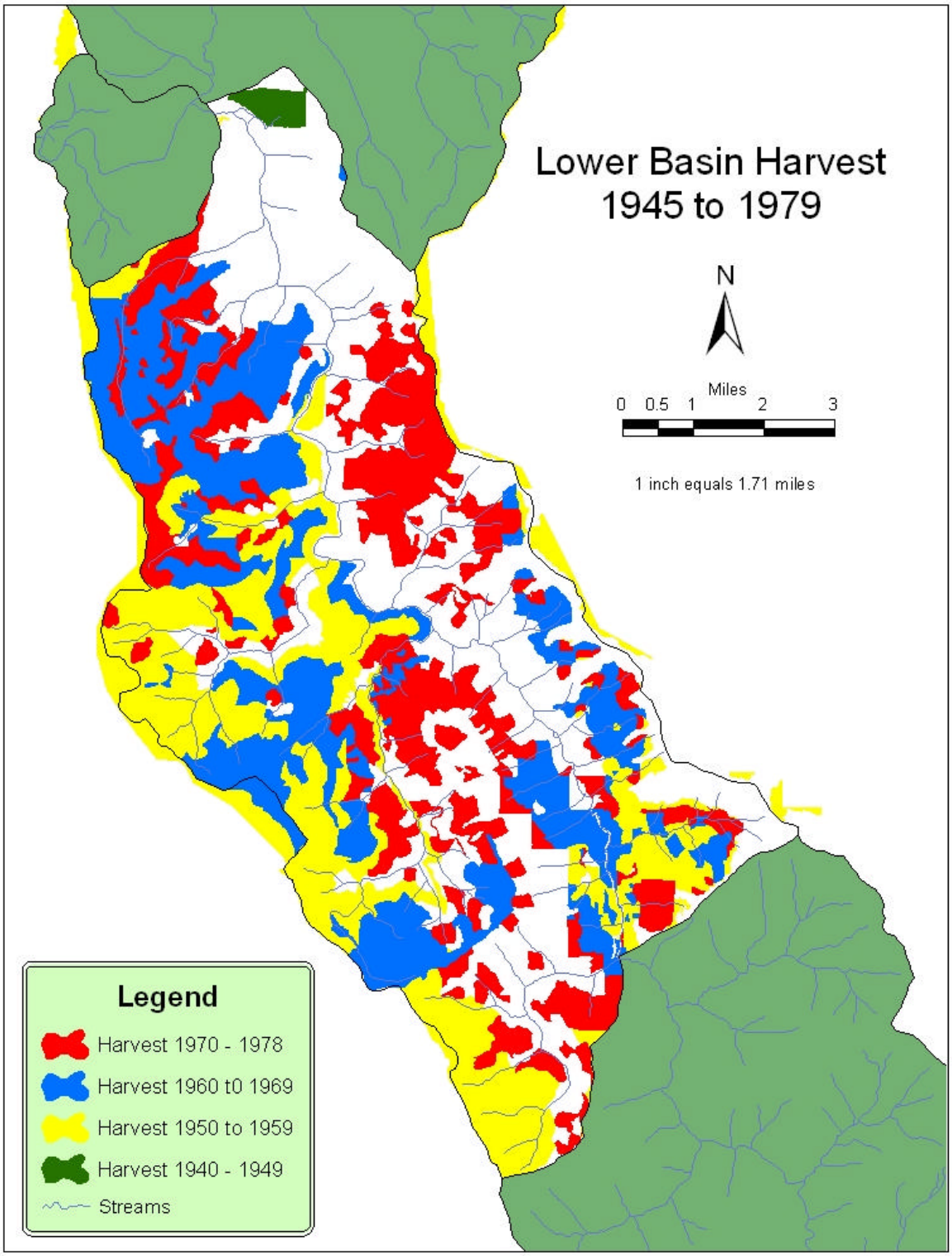

Figure 10. Timber Harvest within the Lower Subbasin of Redwood Creek.

Harvest rates within the lower subbasin were very uniform when comparing the acres of timber harvested during various time periods and events (Table 7). Time period from 1945 to 1955 was the initial harvest entry into the sub basin until the 1955 flood. Period two is that time from the 1955 flood until the 1964 flood. The few years from the 64 flood until the initial park purchase make up period three. The final time period is from 1969 until the second park expansion of 1978. The annual rates of harvest from 1956 until the final harvest in 1978 appear to be fairly even.

Table 7. Harvest Rates and Acres Logged within Lower Redwood Creek from 1945 to 1978.

Time Period Comparison		
Time Period	*Harvest Acres*	*Annual Average*
1945 - 55	3,593	326
1956 - 64	9,627	1,069
1965 - 68	4,365	1,120
1969 - 78	11,069	1,106

Middle Basin Harvest

Timber harvesting within the middle subbasin has been ongoing for many years (Figures 11 and 12). Harvest operations were noted on the 1948 air photo series. Ground based yarding methods were the main system utilized in this sub basin. A total of 40,059 acres have been harvested within this sub basin. The highest amount of logging took place during the decade of the 1980's when 50 percent of the area was harvested. Even-aged silviculture is very predominant within the subbasin. Recent operations have centered on the rehabilitation of the understocked areas that now support stands of tanoak. Harvesting of the tanoak and reestablishing conifers is being undertaken land managed by the timber companies.

Table 8 compares the acres of harvest on the middle and upper subbasins for several periods from 1950 through 2000. Note the particularly high levels of harvest on both subbasins during the 1980s.

Table 8. Comparison of the Acres Harvested for the Middle and Upper Subbasins, 1950 to 1999.

Years	*Middle Sub Basin*	*Upper Sub Basin*
1950 - 1959	1,960	1,117
1960 - 1969	1,505	741
1970 - 1979	8,553	1,147
1980 - 1989	24,750	13,693
1990 - 1999	3,291	729

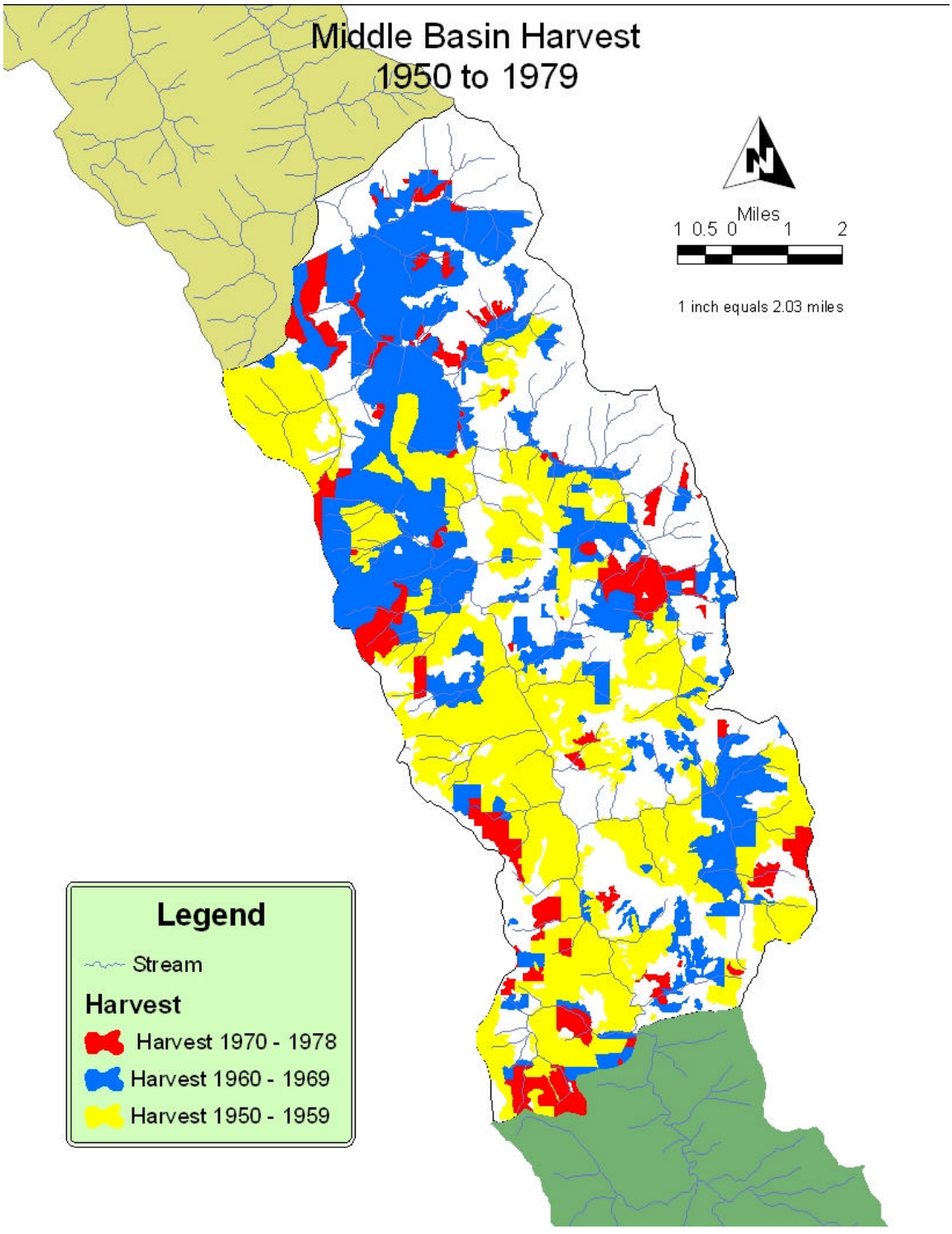

Figure 11. Timber Harvests in the Middle Subbasin of Redwood Creek, 1950 –1979.

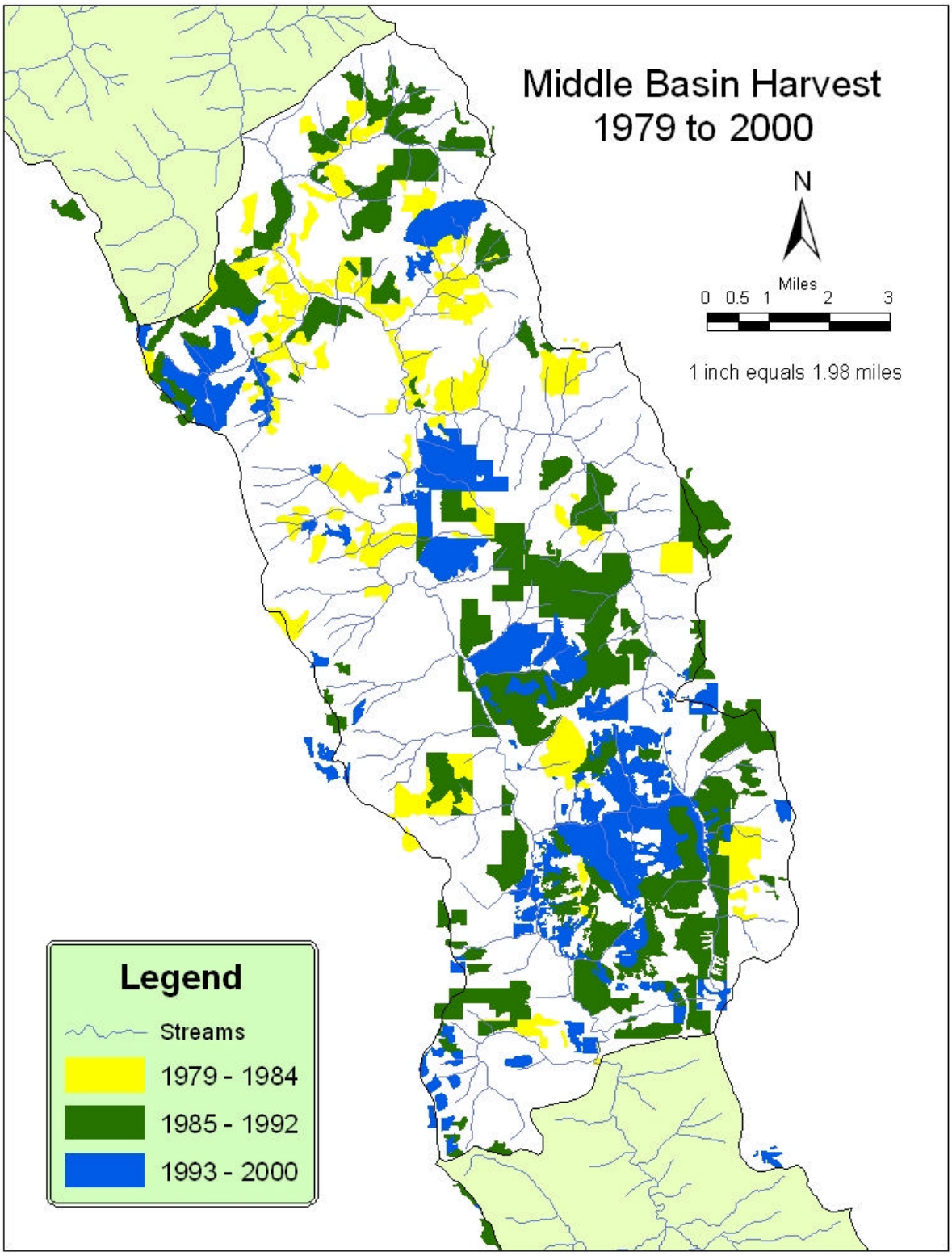

Figure 12. Timber Harvest within the Middle Subbasin of Redwood Creek, 1979 to 2000.

Recent Harvest Methods in the Middle and Upper Subbasins

Timber harvesting has continued within the area of Redwood Creek upstream of the National Park boundary since the expansion of the Park in 1978. For this portion of the assessment, upper Redwood Creek is considered to be the area up stream of the Park boundary near Coyote Creek, up to the basin headwaters at Board Camp Mountain. This section of the assessment was not broken down by subbasins as in the THP assessment due to the similar management activities, road systems and common ownerships within the two sub basins. Of the 107,000 acres within the upper basin, approximately 54 percent was harvested during a 24 year time span (Figure 13). From the period of 1977 to 2000, approximately 58,000 acres operated on. An average of 2423 acres per year was harvested during these 24 years.

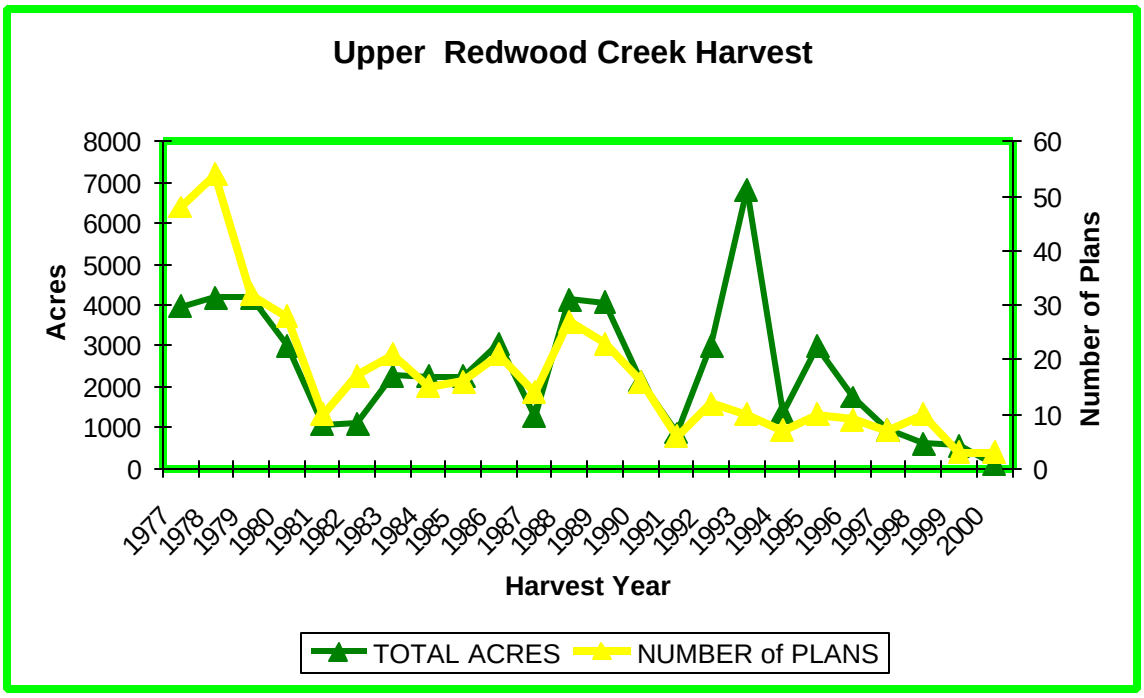

Figure 13: Timber Harvest Plan Numbers and Acres Redwood Creek for Middle and Upper Subbasins, Redwood Creek, 1977-2000.

Review and approval of timber harvest plans is under the authority of the Department of Forestry and Fire Protection. A total of 419 harvest plans were reviewed and approved by that agency from 1977-2000. During this time period the number of timber harvest plans approved on an annual basis has decreased. The peak of 54 plans in 1978 has decreased to the current low of less than 10 per year. A portion of the reduction in plan number may be explained by the changes in timber type and size. While plan numbers have decreased, average plan size has increased. During the late 1970s the average plan size was approximately 80 acres. For the year 1998 the average plan size had increased to 187 acres. Part of this change may be due to the change in silviculture prescriptions

and regulatory changes. Present day timber size and density indicates there is not a large amount of commercial size timber acreage available for harvest.

The peak of acres harvested was in part due to the increase in economic conditions. The large spike in the graph (Figure 13) for the acres harvested in 1993 is the partial result of several plans being submitted for a relatively large number of acres. Rehabilitation of understocked (Rehab) areas was employed on several large areas. Commercial thinning and sanitation salvage were employed to a limited extent.

Silviculture and Yarding

Silviculture and yarding changes also were assessed for the middle and upper subbasins of Redwood Creek (Figure 14). Twelve separate silviculture prescriptions and intermediate treatments were utilized during the 12-year period from 1989 to 2000. Clear cutting (CLCT) accounted for the largest method used. Although clear-cutting is still heavily employed, its overall use appears to be decreasing in the upper Redwood Creek area. For the 24-year period 29.7 percent of the acres harvested were clear-cut. Rehabilitation of understocked (REHB) areas was employed on 16.4 percent of the acres harvested. Use of this silviculture prescription is employed to reclaim vast acres and reestablish conifers. This treatment is occurring mainly on industrial timberland. The extensive tanoak stands may have developed from the post World War II harvest of the extensive Douglas-fir stands found in the Upper Redwood Creek area.

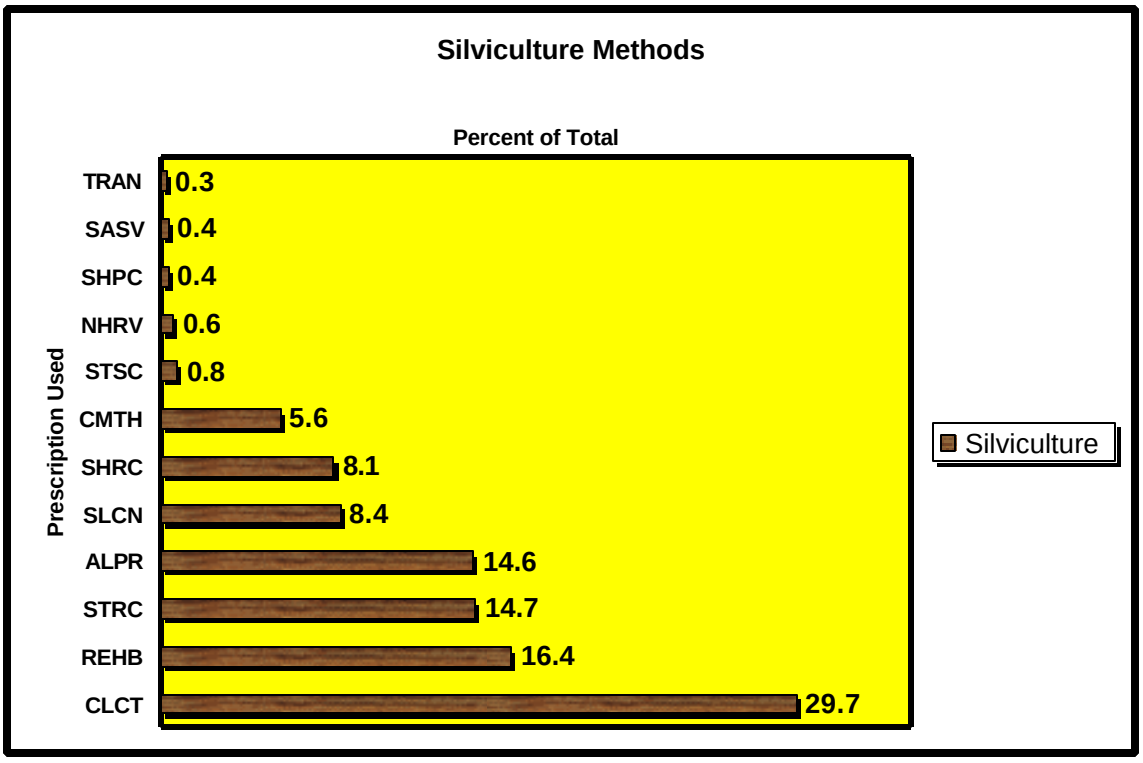

Figure 14. Upper Redwood Creek Silvicultural Methods and Intermediate Treatments, 1989 to 2000.

Recent years have seen the increased use of other silviculture methods and treatments. Commercial thinning (CMTH) and selection harvests (SLCN) are increasing during the recent years as compared to the decade of the 1970's. Selection harvest was applied to 5.6 percent of the areas harvested. Generally this silviculture system is limited due to the lack of all age stands found within the upper basin area. Areas of "No Harvest" (NHRV) is another forest management tool, which has become utilized during recent years. These areas are utilized for wildlife protection measures and came on the scene during the mid 1990's. The limited use of sanitation – salvage (SASV) would indicate the overall health of the forest is in good condition. Increased use of the commercial thinning intermediate treatment should be observed in the future. The young growth stands are well stocked and may require intermediate treatments to increase forest growth and yield.

Alternative prescriptions (ALPR) was applied to 14.6 percent of the harvest plans. These alternative prescriptions usually resembeled a shelterwood removal or clear-cut. As an alternative to the standard prescriptions these methods were used to protect components of forest resourcses which could not otherwise be safe garded. Areas generally safe guarded were generally associated with wildlife issues or watercourse portection measures. Use of a shelterwood removal cut (SHRC) along with the seed tree removal cut (STRC) was usually applied to areas in which the residual timber was to be removed. Well stocked understories are required in the Forest Practice rules for these two prescriptions to be applied. The remaining prescriptions were utilized on a limited basis. Their use would appear to be on a very site explicit basis to achieve a desired stand result.

Yarding methods employed on timber harvest plans within the upper Redwood Creek area are divided into three separate systems (Figures 15 and 16). Ground based skidding accounts for 77 percent of this total. Of the approximately 58,000 acres harvested 44,600 were yarded with ground based equipment. Cable yarding systems were used to yard an additional 9850 acres. This category includes all types of cable yarding systems. It was not broken down into highlead, short span or long span skyline. Helicopter yarding was utilized for the yarding of six percent of the plan area. Most of the helicopter yarding was used in clear-cut or shelterwood removal units. Ground based yarding was used in all types of silviculture units. Cable yarding appears to have been limited to rehab units, shelterwood removal areas and clear-cuts. Cable yarding was used in one harvest plan to yard several small commercial thinning units.

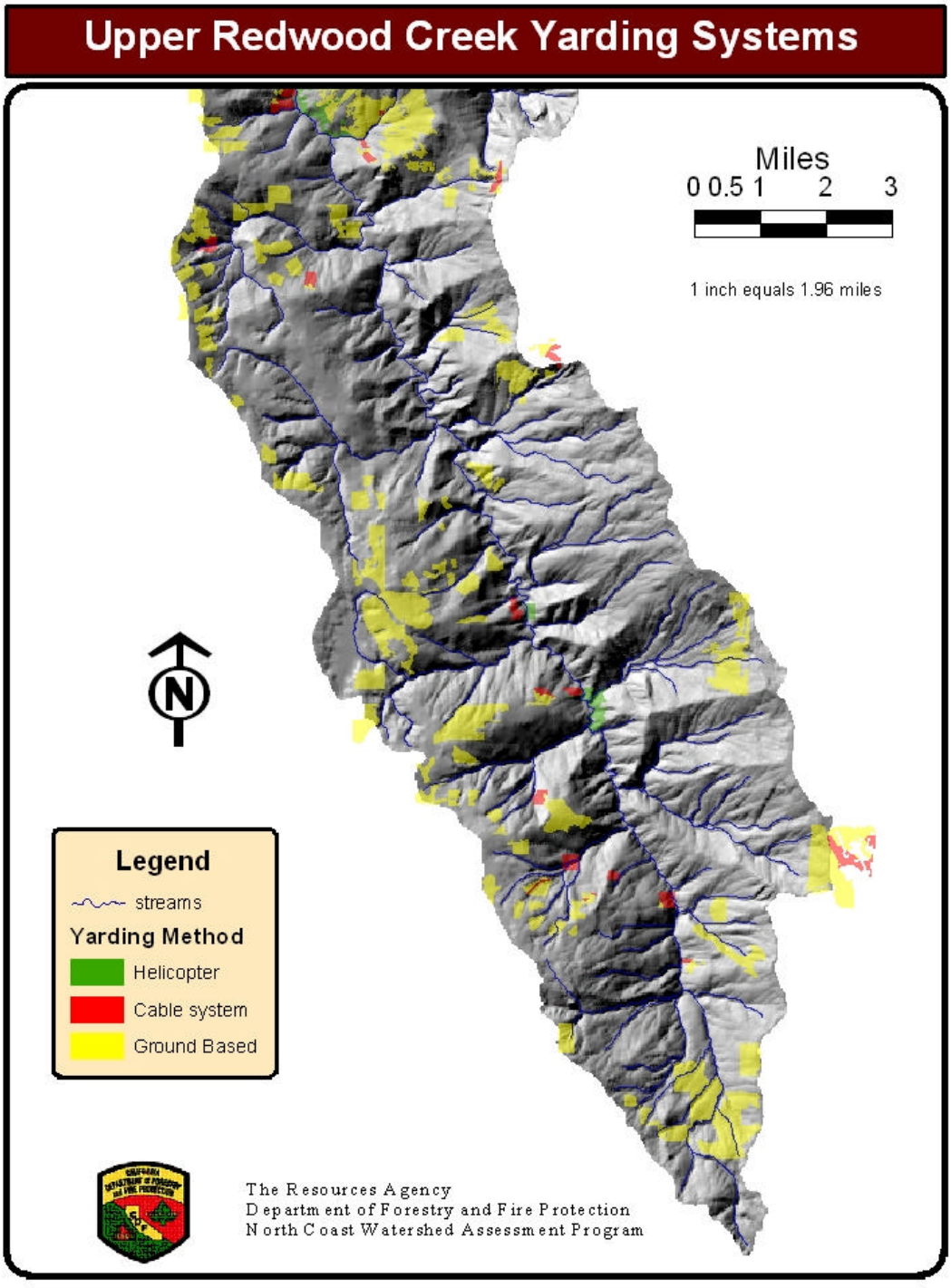

Figure 11: Yarding systems within the upper portion of Redwood Creek.

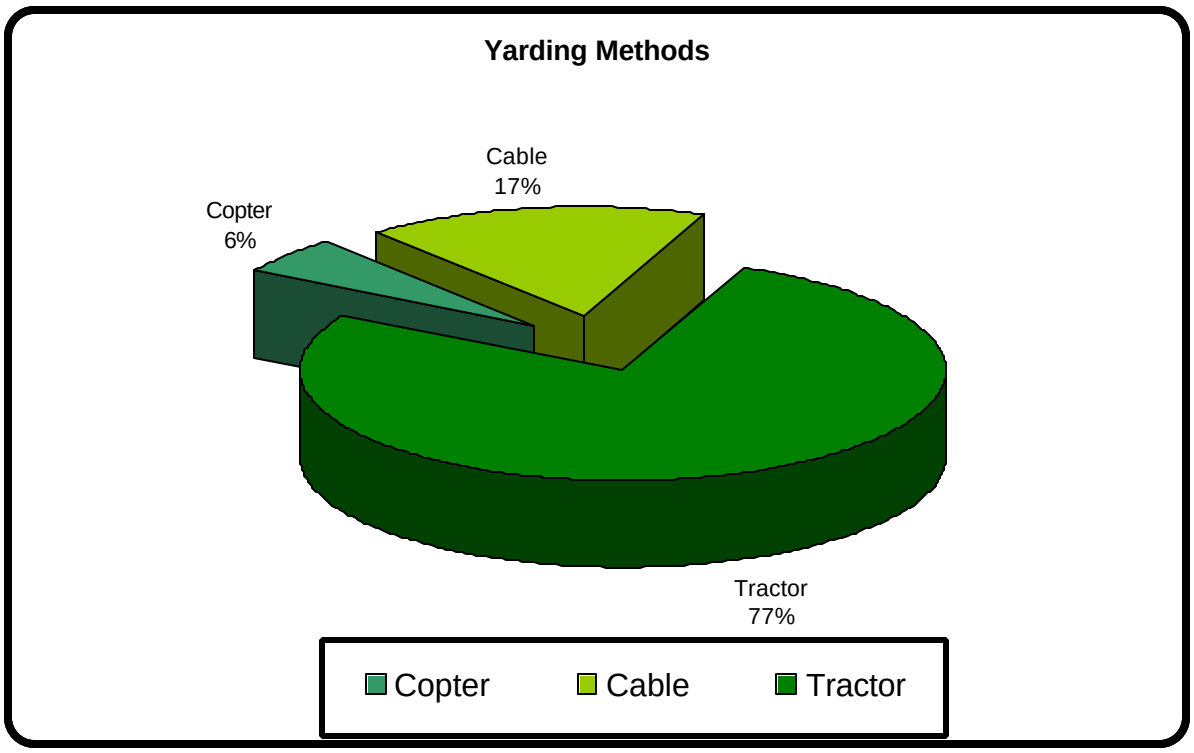

Figure 12: Upper Redwood Creek Yarding Systems Utilized during the period of 1989 to 2000.

Review of the harvest plan locations in relation to their position on the slope was also assessed. Harvest plans for the past ten years were overlaid on a digital elevation model. Generally the cable yarding operations were utilized on the slopes greater than 50 percent. Cable yarding was also used to span watercourses due to limited roads access to one side or the other. These areas appear to be deep narrow canyons where cable suspension could be maintained. Helicopter yarding was used to access areas of steep slopes and in selected area where access was limited.

Upper Basin Harvest

Within the upper basin 17,427 acres have been harvested (Table 8, above, Figure 17). The highest amount of logging took place during the decade of the 1980s when 78 percent of the area was harvested. Even-aged silviculture is the primary method utilized within the sub basin. Ground based yarding methods were the main system utilized in this sub basin.

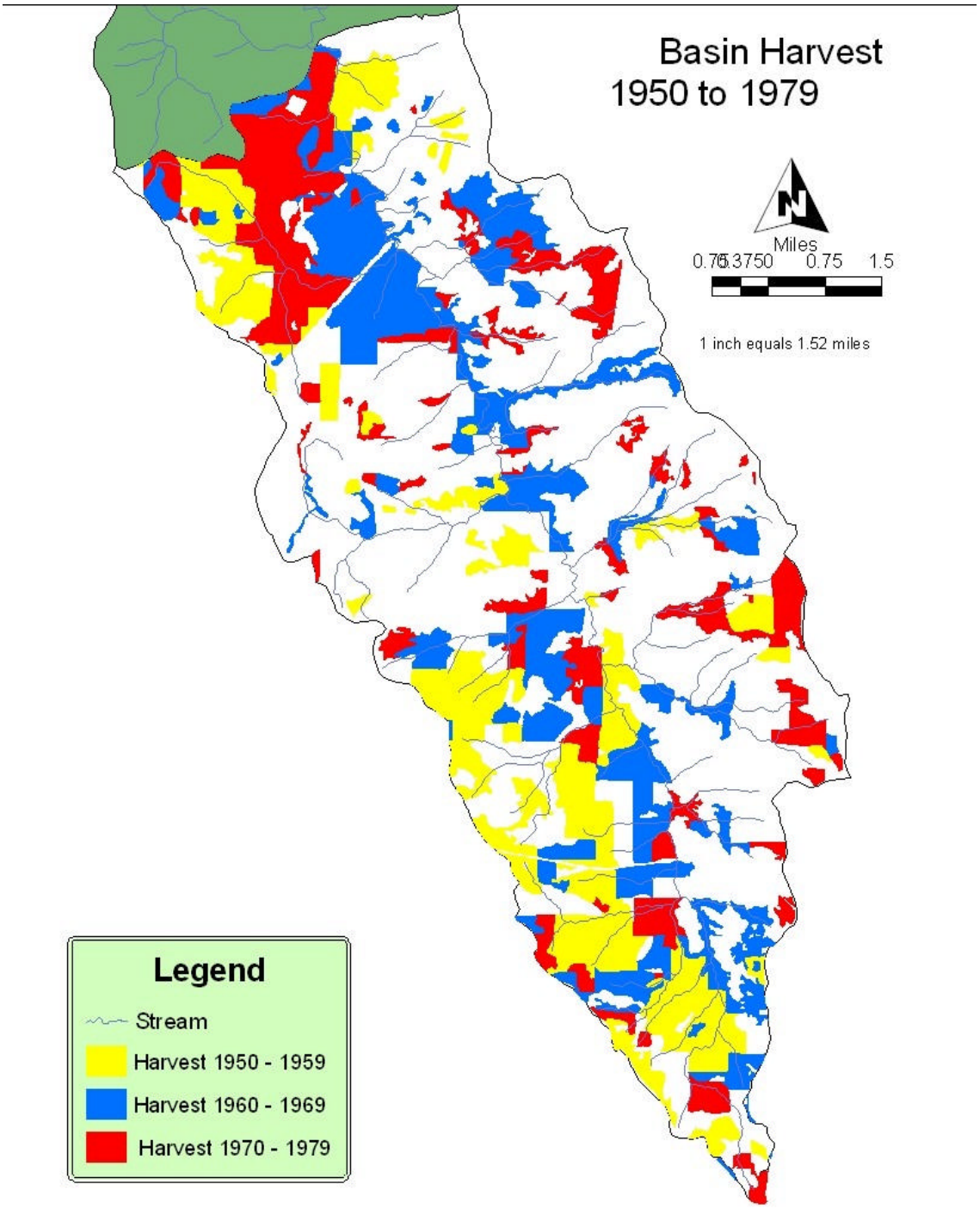

Figure 13: Timber Harvest in the Upper Subbasin of Redwood Creek, 1950-1979.

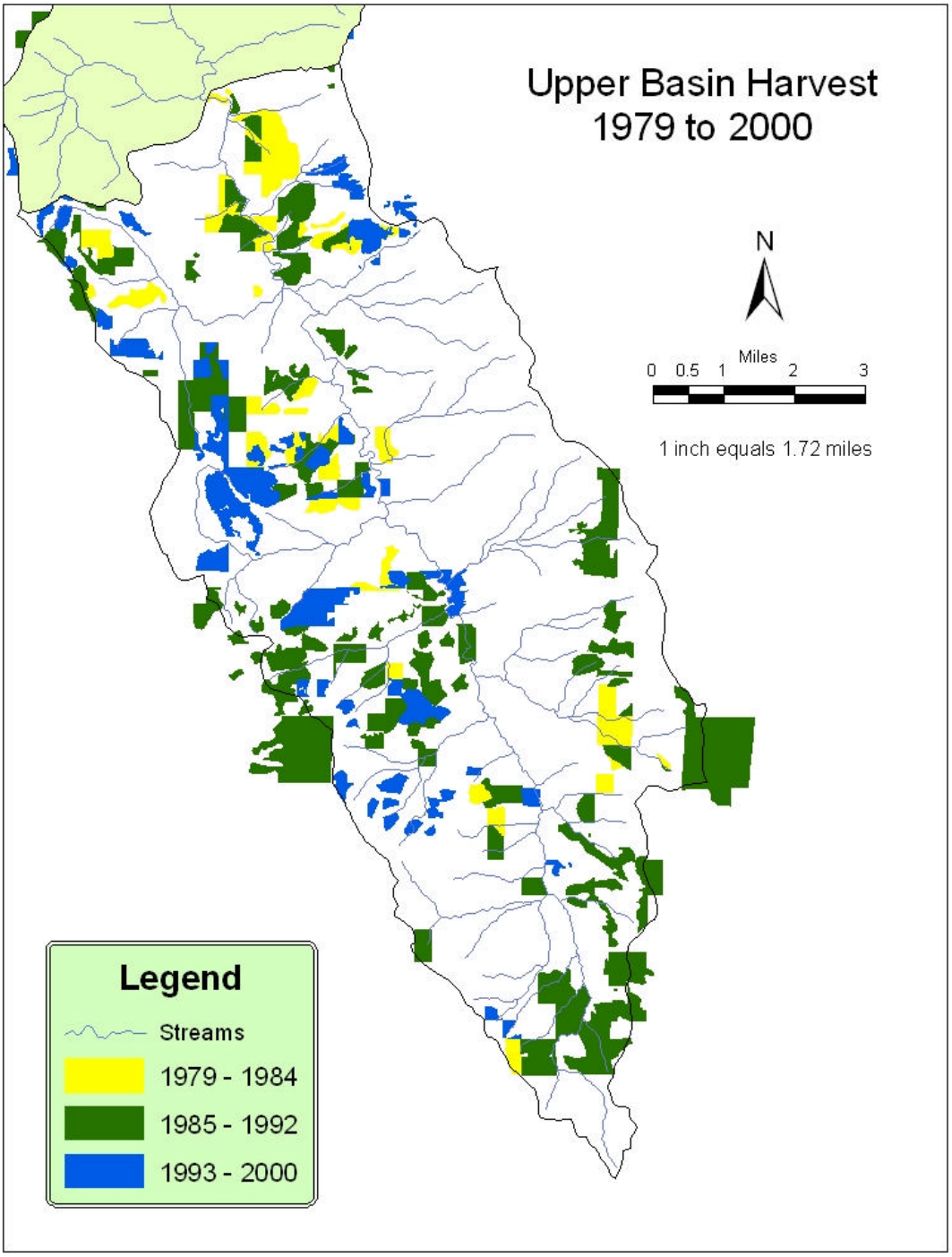

Figure 14. Timber Harvest in the Upper Subbasin of Redwood Creek, 1979-2000.

Roads

There are approximately 1,700 miles of roads within the basin of Redwood Creek. Redwood National Park has estimated that about 50 miles of roads are located within the inner gorge of a watercourse. Only the major highways and several county roads are paved. The remainder of the roads within the drainage are surfaced with either native material, gravel or rock from a local source. In addition, the majority of these road (66%) (RNP 2001) were constructed prior to 1964. Between 1964 and 1978 14 percent of the roads were build. An additional 20 percent were added between 1978 and 1992.

Road density information in the KRIS along with Cedarholm et al. (1982) suggest that fine sediment increase in watersheds with more that 3 miles of roads per square mile of area. Currently Redwood Creek has approximately 4.79 miles of road per square mile for the entire watershed (Figure 19). This number drops to 2.15 miles of road per square mile of area within the State and National Parks. Up stream of the Park this road length per square mile increases to 6.72 miles of roads per square mile on private ownerships. The USFS and BLM ownerships in Redwood Creek have 4.80 miles of road per square mile of ownership.

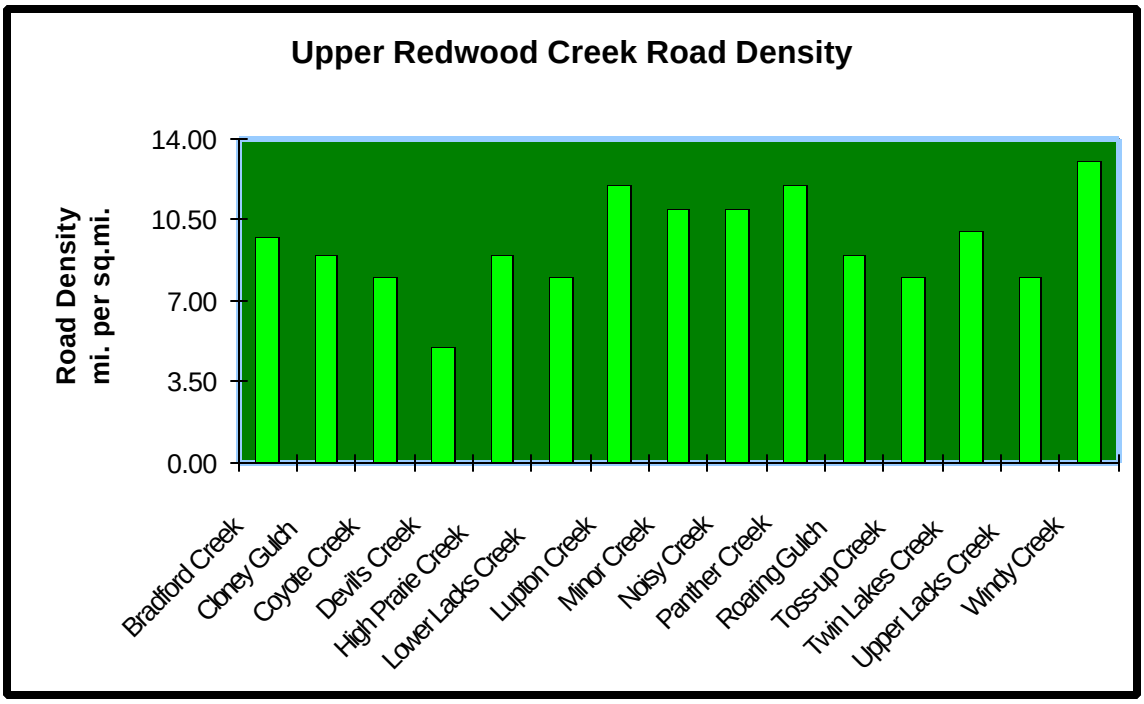

Figure 15:Road Density for Selected Planning Basins within the Middle and Upper Basins of Redwood Creek.

The road-decommissioning program within the National Park has treated or removed 214 miles of roads since the program began in 1978. Road assessment for the Redwood Creek basin has been completed or is nearing completion. Assessment work in Lupton Creek, Noisy Creek, Pardee Creek, Toss Up Creek and Roaring Gulch are planning watersheds which have been funded. The immediate objective of this watershed improvement-planning project is to develop site-specific projects that address the most significant factors negatively affecting habitat for anadromous salmonids in this portion of the Redwood Creek watershed. The long-term objective is to complete an assessment and planning effort for all private lands in Redwood Creek so that a single restoration plan can be developed for the entire basin. With the funding and implementation assessment program, roughly 90% of the private lands in Redwood Creek will have been inventoried. The remaining portion containing smaller, mixed ownerships would be submitted for funding during the next funding cycle.

The vast majority of the roads in the watershed were constructed during the initial timber harvest period. Most of the private road construction was for the purpose of timber harvesting. With changes in the forest Practice Regulations new construction has to meet a higher standard. These regulations cover construction activities such as operations on steep slopes, road alignment, road grads, erosion control, watercourse crossings, culvert instillation, winter period operations and road maintenance. This project is specifically intended to provide a prioritized plan for reducing the affect of the roads on stream channels. Roads currently used for access to conduct timber harvest operations may be upgraded by the landowner. Some landowners have already taken action to upgrade many of their roads and watercourse crossings. The recommendations and findings of this road assessment work should be included in the final Redwood Creek Assessment Plan.

Although the new construction undertaken by CALTRANS was for a new freeway by-pass, this project did account for excessive amounts of runoff and sediment production by the time the project was finished in 1992. Impacts of concern occurred during a heavy rainstorm in October 1989.

Fire

Coastal redwood forest, especially the moist sites along the coast have a lower incidence of fire that the drier upland forests within Redwood Creek. Lightning fires do not appear to be frequent near the ocean but their significance as an ignition source increases with the distance from the coast and rise in elevation. Intense fires occur at intervals of greater that 500 years in the more music sites (Veiers 1980), 150 to 200 years on the mid-elevation slopes and 50 years at the dryer inland areas.

The use of fire has long been used as a land management tool within Redwood Creek. Forests were burned on a frequent basis to reduce the fuel loading as an aid to hunting. The use of fire as a management tool was well utilized by the lumber industry. During the steam era period forests within Redwood Creek burned prior to yarding. Generally these areas were burned after the large timber was felled and the bark was removed. Once this was done burning was utilized to remove the significant amount of logging debris and

bark that was in the unit. Removal of this debris made the yarding of the logs much easier but resulted in an increase in sediment generation from the burned unit. Fire is used today as part of modern silvicultural practices. Burning of a clear cut unit is utilized for the preparation of the area for planting and regeneration of the site. Burning prescriptions outline the use of light ground fires to reduce the fine fuels but retain the larger more course debris as future wildlife habitat. Redwood National Park also utilizes prescribe fire as part of their management plan.

Within recorded history fires have been a common part of Redwood Creek. As Table 9 show and Figure 20 show, 1,855 acres have been burned within the drainage since 1950. Due to the difference in reporting methods, the number of fires and the acres burned for the National Park Service (NPS) includes the prescribed fires that Park conducts on an annual basis. Some of these burned areas in the Park reflect grassland, which has been burned multiple times to control unwanted vegetation. It should also be noted that approximately 79 percent of this total resulted from on fire. The "Healy Logging Fire" on the second of September 1955 burned a total of 22,508 acres. The fire started in the lower portion of Tully Creek, just north of School House Peak, and burned into Redwood Creek In addition to these burned acres the timber companies would utilize prescribe fire on an annual basis. Fire was used as a site preparation tool to make ready the clearcut units for planting. The number of fires is not reflected in the table three unless the fire escaped control lines and required suppression by one of the fire suppression agencies.

Table 9. Acres Burned and the Number of fires by Responsible Agency, since 1950.

Agency	Number of Fires	Total acres burned
CDF	7	334
NPS	116	1422
USFS	11	99
TOTAL	234	1855

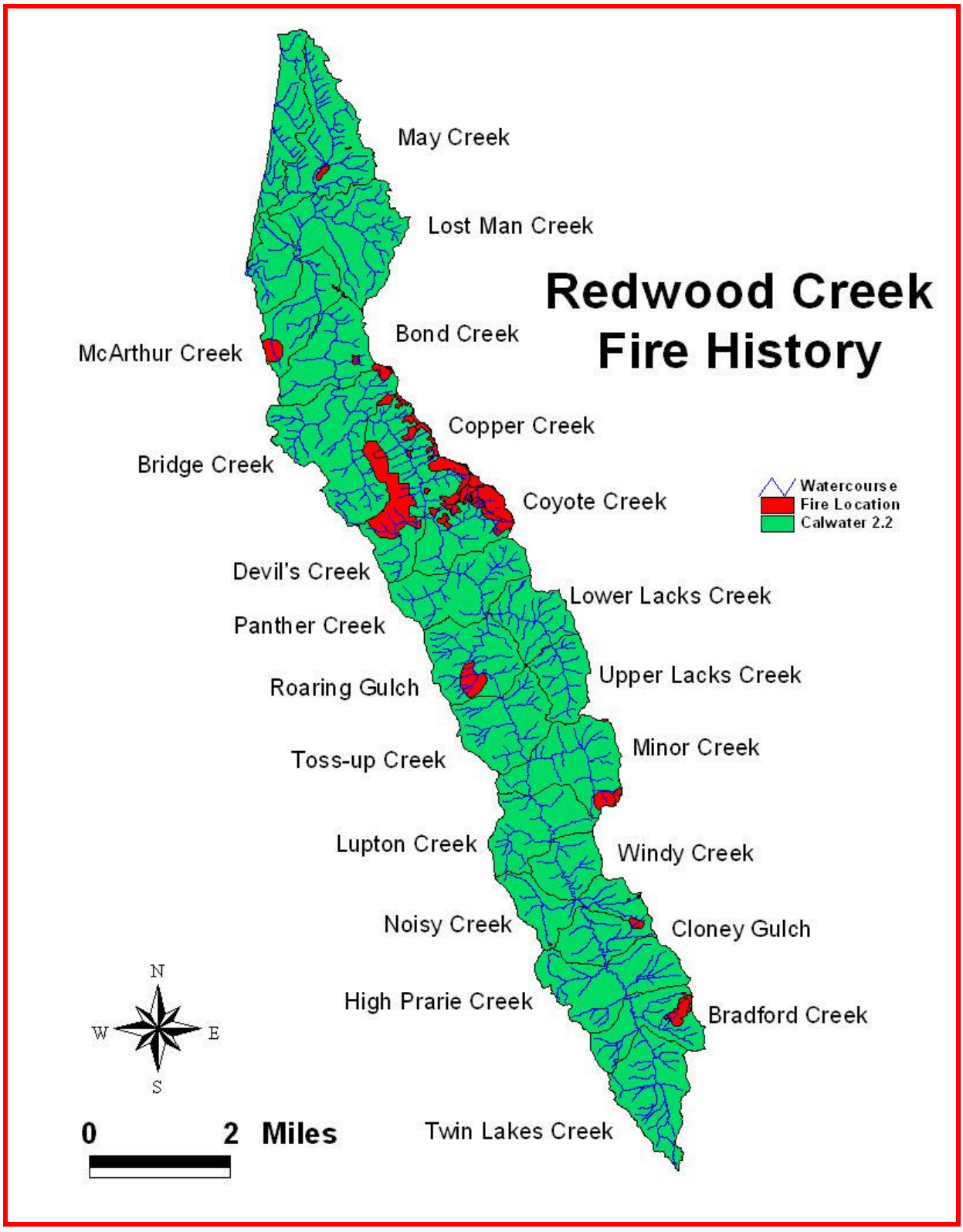

Figure 16. Redwood Creek Fire History.